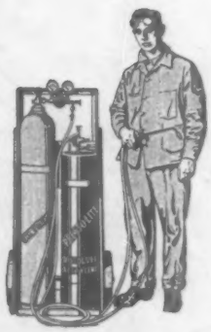
The Welding Engineer

Vol. II. Chicago 608 S. Dearborn St. AUGUST, 1917 $2.00 per year in U. S. $2.50 per year abroad No. 8

Prest-O-Lite

Acetylene Service



BACKED by the world's largest acetylene producing and distributing organization —a country-wide system of factory branches, charging plants and exchange stations, insuring prompt, permanent, universal service

Prest-O-Lite Acetylene Service furnishes the highest grade of dissolved acetylene, ready to use, in portable cylinders of convenient size, for welding and cutting.

It insures maximum efficiency, economy and satisfaction, because Prest-O-Lite is perfectly dried, cleaned and purified. It increases the efficiency of any good welding or cutting apparatus—makes possible better, quicker work, at lower cost.

The Prest-O-Lite Engineering Department is alway ready to assist in solving the problems of Prest-O-Lite users. And a staff of skilled welding men, stationed at various centers is ready at all times to give practical help to our patrons.

Whatever your welding and cutting problems may be, we will gladly assist in finding the solution. You will receive prompt, expert attention.

The Prest-O-Lite Co., Inc.

U. S. Main Office and Factory, 851 Speedway, Indianapolis, Ind.
Canadian General Office, Dept. B. 1, Toronto, Ontario

59 Branches and Charging Plants in Principal Industrial Centers

World's Largest Makers of Dissolved Acetylene

The largest makers of Oxy-Acetylene Welding and Cutting Equipment and Supplies in the World

Oxweld Equipment includes Acetylene Generators, Welding and Cutting Blow Pipes, Regulators and Supplies—everything needed for all requirements—complete installations for the most extensive manufacturing and repair operations to portable units for emergency and field use. Because of the scientific accuracy and exactness of design—high quality materials and the mechanical perfection of construction and workmanship. **OXWELD EQUIPMENT** will produce the most efficient and economical results in welding and cutting operations of every character.

Oxweld Supplies are made up in accordance with the formulae of our metallurgists—tested by analysis in our laboratory and their merits tested out and proven by our expert welders in actual shop practice. We guarantee **OXWELD SUPPLIES,** when used by competent welders, to produce better results than any others known to the art today.

Our knowledge and experience, as the largest makers of welding and cutting equipment in the world, are always at the service of every purchaser and prospective purchaser of **OXWELD APPARATUS,** to determine the most economical and efficient applications of the **PROCESS** to the manufacturing or repair problems at hand.

Write us for information on any class of Welding or Cutting Work

Oxweld Acetylene Company

CHICAGO
36th St. and Jasper Place

NEWARK, N. J.
646-686 Frelinghuysen Ave.

LOS ANGELES
654-656 Pacific Electric Bldg.

"Fyber-Weld" Industrial Goggle

The Welder's Delight—Made of fibre—an absolute Non-conductor of Heat. Light and durable.
No. 510. Fitted with Our Famous Essentialite Lenses the exact glass for protecting the delicate organism of sight against Ultra-Violet and Infra Red rays.
Price $3.00 per pair.

No. 510. Fitted with Smoke Green Lenses.
Price $2.50 per pair.

Fyber Spectacle

No. 511. Fitted with Smoke Green Lenses. $1.00 per pair.

No. 511. Fitted with "Essentialite" Lenses. $1.50 per pair.

Manufactured exclusively by

THE CHICAGO EYE SHIELD CO.

Safety Dept. No. 33

2300 Warren Ave. **Chicago, Illinois**

Use Kerosene

For PREHEATING in Connection with Your Welding Torch

Cut down the cost of Welding more than 50% and turn out Better Work

HAUCK MFG. CO.

BROOKLYN, N. Y.

EFFICIENCY of a weld not only depends on the manner in which it is executed, but also on the grade and amount of material used.

In view of this, our engineers have developed the highest grade of various welding materials known to the art.

OXWELD RODS are furnished in convenient packages and are made for every class of material that can be welded, whether it be copper, brass, aluminum, steel, low or high carbon, chrome vanadium or ordinary steel castings.

We maintain a complete staff of experts qualified to handle and supervise all lines of work.

Oxweld Railroad Service Company

CHICAGO **NEW YORK**

MILBURN APPARATUS

Milburn mixing principle produces best work with minimum gas, and no flash backs, burnt tips, or other annoyances.

Exceptionally durable construction of torches insures long, satisfactory service. Regulators dependable and free from valve, diaphragm and gauge troubles.

Ask for Catalogue No. 35.

The Alexander Milburn Compan

Baltimore, **Marylanv**

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Commercial Acetylene Welding Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.

ACETYLENE CYLINDERS

ACETYLENE GENERATORS
Bermo Supply Co.
Davis-Bournonville Co.
The Harris Calorific Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

ALUMINUM FILLER RODS
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Mach. Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

ALUMINUM FLUX
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

ALUMINUM SOLDER
Vulcan Process Co.

ANNEALING FURNACES
Buffalo Dental Mfg. Co.
Universal Oxygen Co.

APRONS (Asbestos)

ASBESTOS GLOVES
Vulcan Process Co.

ASBESTOS SHEET PAPER
Davis-Bournonville Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

BLOW TORCHES (Acetylene)
American Welding Co.
Bermo Supply Co.
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
The Alexander Milburn Co.
The Prest-O-Lite Co.
Vulcan Process Co.

BOOKS (Relating to Welding)
The Welding Engineer
P. F. Willis.

BRASS AND BRONZE FLUX
American Welding Co.
Hauck Mfg. Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
United States Welding Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Vulcan Process Co.

BRASS SPELTER WIRE
Universal Oxygen Co.
Vulcan Process Co.

BRAZING OUTFITS
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Superior Oxy-Acetylene Machine Co.

BRONZE FILLER RODS
Hauck Mfg. Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

BUTT WELDERS (Electric Resistance)
Thomson Electric Welding Co.

CARBIDE (Calcium)
Canada Carbide Sales Co.
Union Carbide Sales Co.

CARBO CUTTING AND WELDING APPARATUS
Carbo-Hydrogen Co. of America

CARBO-HYDROGEN
Carbo-Hydrogen Co. of America

CARBON REMOVING TORCHES
American Welding Co.
The Bastian-Blessing Co.
Bermo Supply Co.
Davis-Bournonville Co.
General Welding & Equipment Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Messer Mfg. Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Mach. Co.
Universal Oxygen Co.
Vulcan Process Co.

CAST IRON FILLER RODS AND FLUX
American Welding Co.
Bermo Supply Co.
Bierman-Everett Fdy. Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

CRANES (Portable)
H. G. Doran.

ELECTRIC ARC WELDING OUTFITS
The Lincoln Electric Co.
Westinghouse Electric & Mfg. Co.
General Electric Co.

ELECTROLYTIC OXYGEN PLANTS
Universal Oxygen Co.
Vulcan Process Co.

FILLER RODS (Aluminum)
American Welding Co.
Bierman-Everett Fdy. Co.
Hauck Mfg. Co.
United States Welding Co.
The Prest-O-Lite Co.
Vulcan Process Co.

FILLER RODS (Swedish Iron)
American Welding Co.
Bierman-Everett Fdy. Co.
Bermo Supply Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
Steel Sales Corp.
Universal Oxygen Co.
Vulcan Process Co.

FILLER RODS (Tobin Bronze)
American Welding Co.
Bermo Supply Co
Bierman-Everett Fdy. Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
Steel Sales Corp.
Vulcan Process Co.
United States Welding Co.
Universal Oxygen Co.

FILLER RODS (Vanadium Steel)
American Welding Co.
Bermo Supply Co.
Bierman-Everett Fdy. Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Steel Sales Corp.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

FIREPROOF PLASTIC
Bermo Supply Co.

FLUX WELDERS (Electric)
Westinghouse Electric & Mfg. Co.

FURNACES (Annealing)
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Universal Oxygen Co.

GASOLINE PREHEATING FURNACES
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.

GAS BURNERS (Preheating)
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Westinghouse Electric & Mfg. Co.
Vulcan Process Co.

GLOVES (Welders Asbestos)
Davis-Bournonville Co.
Vulcan Process Co.

GOGGLES
Chicago Eye Shield Co.
F. A. Hardy & Co.
Vulcan Process Co.

GRINDING MACHINES

HARDENING FURNACES
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.

HOSE (Carbo-Hydrogen)
Carbo-Hydrogen Co. of America

HOSE (Oxygen and Acetylene)
American Welding Co.
Bermo Supply Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co
The Prest-O-Lite Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

HOISTING MACHINERY

HOSE UNIONS
Bermo Supply Co.
K-G Welding & Cutting Co.
Hauck Mfg. Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

HYDROGEN
Universal Oxygen Co.
Vulcan Process Co.

KEROSENE PREHEATING TORCHES
Alger Supply Co.
Hauck Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

NEEDLE VALVES
The Bastian-Blessing Co.
Bermo Supply Co.
Buffalo Dental Mfg. Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

The Growth of Oxy-Acetylene Welding and Cutting and the Increasing Demand for Davis-Bournonville Apparatus

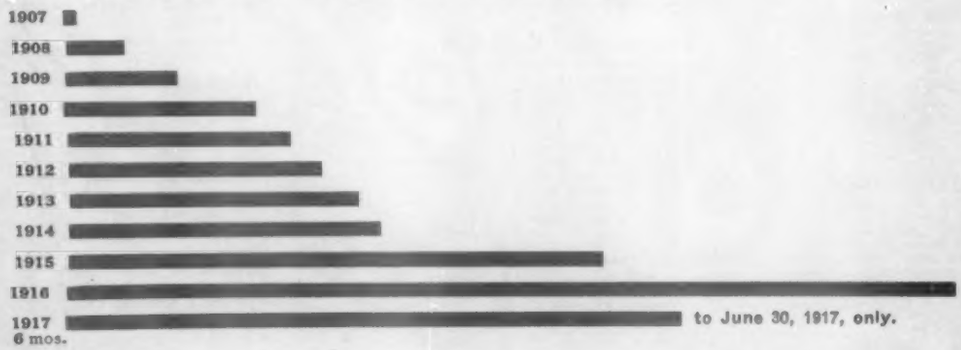
A Year Ago we said—

"The growth of Oxy-Acetylene Welding and Cutting in the United States is shown by the increasing use of Davis-Bournonville apparatus, which is inseparably associated with the development and success of the oxy-acetylene industry in this country.

"Ten years ago the process was unknown in the United States. Today it forms one of the great industries of the country, with its requirements for acetylene, oxygen and efficient apparatus.

"The Davis-Bournonville Company obtained the United States patents for the independent positive-pressure type of welding torch (mixing the gases in an interchangeable tip or nozzle) in 1906—basic principles which have been retained in the D-B torch because of their proven superiority through ten years of development, improvement and the most successful operation. "There is more Davis-Bournonville welding and cutting apparatus in successful use in the United States than of any other make, and the prominent concerns which have established the greatest success with this process have large installations of D-B apparatus, with from ten to one hundred or more torch units, and from one to six of the largest acetylene generators."

Today— The increasing use of the oxy-acetylene process for welding and cutting and of Davis-Bournonville apparatus are parallel and are graphically shown by the sales of "Davis Apparatus" as charted below:



"Davis Apparatus" Leads the World in Range, Efficiency and Number of Successful Users. Write for bulletins and information showing why it is used by the largest steel mills, foundries, ship-yards, locomotive and car builders, U. S. Navy Yards and government works, mines, sheet metal working factories, tube and barrel welders, scrap yards, and in hundreds of small repair shops and garages.

DAVIS-BOURNONVILLE CO.

General Offices and Factory, Jersey City, N. J.

NEW YORK	PITTSBURGH		CHICAGO	SEATTLE
BOSTON	CLEVELAND		DETROIT	SAN FRANCISCO
PHILADELPHIA	CINCINNATI		ST. LOUIS	TORONTO, ONT. (Carter Welding Co.)

OIL BURNERS (Preheating)
Alger Supply Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Mach. Co.
Vulcan Process Co.

OXYGEN (Compressed in Cylinders)
Burdett Oxygen Co.
The Linde Air Products Co.
Swift & Co.
Universal Oxygen Co.
Vulcan Process Co.

OXYGEN CYLINDERS

PIPE WELDING
Goldschmitt Thermit Co.

PHOTOGRAPHS
Chicago Architectural Photographing Co., (Specialists in photographs relating to the welding industry)

PLASTIC (Fireproof)

PRESSURE GAUGES
American Welding Co.
Bastian & Blessing Co.
Bermo Supply Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
U. S. Gauge Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

RAILROADS—Special Service for
Oxweld Railroad Service Co.

REGULATING VALVES (Acetylene)
American Welding Co.
The Bastian-Blessing Co.
Bermo Supply Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
The Prest-O-Lite Co., Inc.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

REGULATING VALVES (Carbo-Hydrogen)
Carbo-Hydrogen Co. of America

REGULATING VALVES (Hydrogen)
American Welding Co.
The Bastian-Blessing Co.
Bermo Supply Co.
The Prest-O-Lite Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Vulcan Process Co.

REGULATING VALVES (Oxygen)
The Bastian-Blessing Co.
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

SCHOOLS OF WELDING

SEAM WELDERS (Electric)
General Electric Co.
Westinghouse Electric & Mfg. Co.

SEAM WELDERS (Electric Resistance)
Thomson Electric Welding Co.

SPOT WELDERS (Electric Resistance)
Thomson Electric Welding Co.

TANK CONNECTIONS (Oxygen and Acetylene Adaptors)
Superior Oxy-Acetylene Machine Co.

THERMALENE-GAS
The Thermalene Co.

THERMIT WELDING
Goldschmidt-Thermit Co.

TORCHES (Carbo-Hydrogen)
Carbo-Hydrogen Co. of America

TORCHES (Gasoline and Kerosene Preheating)
American Welding Co.
Alger Supply Co.
Buffalo Dental Mfg. Co.
General Welding & Eq. Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Westinghouse Electric & Mfg. Co.
Vulcan Process Co.

TORCHES (Oxy-Acetylene Cutting)
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Messer Mfg. Co.
Welding Supply Co.
K-G Welding & Cutting Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

TORCHES (Oxy-Acetylene Welding)
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Messer Mfg. Co.
Welding Supply Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

TORCHES (Oxy-Hydrogen Cutting)
American Welding Co.
Bermo Supply Co.
Davis-Bournonville Co.
Messer & Co.
Welding Supply Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Alexander Milburn Co.
The Imperial Brass Mfg. Co.
Vulcan Process Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

TORCHES (Oxy-Hydrogen Welding)
American Welding Co.
Bermo Supply Co.
Messer Mfg. Co.
Welding Supply Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Vulcan Process Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
United States Welding Co.
Universal Oxygen Co.

TORCHES (Special to Order)
American Welding Co.
Bermo Supply Co.
The Harris Calorific Co.
Superior Oxy-Acetylene Machine Co.
Vulcan Process Co.

TRUCKS (Cylinder Carriers)
American Welding Co.
Davis-Burnonville Co.
M. Desmond Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Vulcan Process Co.

VALVES (For Oxygen Cylinders)
The Bastian-Blessing Co.
Universal Oxygen Co.
Vulcan Process Co.

WELDING (Electric Resistance-Custom Work)
Thomson Electric Welding Co.

WELDERS' GOGGLES
Chicago Eye Shield Co.
F. A. Hardy Co.
Vulcan Process Co.

WELDING (Oxygen for)
The Linde Air Products Co.
Universal Oxygen Co.
Vulcan Process Co.

WELDING RODS
Bierman-Everett Fdy. Co.
Vulcan Process Co.

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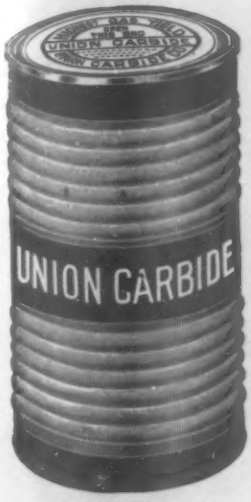

Packed in Blue and Gray Drums

Union Carbide Sales Company

New York City, 42nd St. Building — **Chicago, Ill., Peoples Gas Building** — **San Francisco, Cal., Kohl Building**

SOLE DISTRIBUTORS OF

UNION CARBIDE

"World's Best Quality—Highest Gas Yield"

For Oxy-Acetylene Welding Plants

Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

The following sizes are carried in stock in 100-lb. drums:

3½ x 2 in. —a large size.

2 x ½ in. —a medium size.

1¼ x ⅜ in. —an intermediate size.

¼ x 1/12 in. —finely crushed size.

Union Carbide in the Generator sizes above listed will be shipped direct to consumers from a **Union Carbide Sales Co.** warehouse at any one of the following points where large stocks are kept on hand:

ALABAMA
Birmingham—1916 Morris Ave.
Mobile—262-268 S. Water St.
Montgomery—114 N. Perry St.
ARIZONA
Phoenix—42 S. Central Ave.
ARKANSAS
Fort Smith—109-123 So. Ninth St.
CALIFORNIA
Eureka—109 Second St.
Fresno—932 H St.
Los Angeles—639 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Building.
COLORADO
Denver—Nineteenth and Waxee Sts.
Victor—Third and Diamond Sts.
CONNECTICUT
Hartford—877 Main St.
DISTRICT OF COLUMBIA
Washington—Maryland Ave. and 9th St., S. W.
FLORIDA
Jacksonville—106 E. Forsyth St.
Tampa—418 Tampa St.
GEORGIA
Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
Savannah—Ogeechee Canal, South of Bay St., P. O. Box 78.
ILLINOIS
Chicago—Peoples Gas Bldg., Michigan Blvd.
Decatur—133-147 W. Williams St.
East St. Louis—600 Walnut Ave.
Peoria—721-731 So. Washington St.
Marion—315 S. Granite St., Box 747.
Monmouth—621 S. First St.
Quincy—223 S. Eighth St.
Streator—702 East Elm St.
INDIANA
Evansville—1601 Illinois St.
Indianapolis—110-112 S. Alabama St.
Terre Haute—921 Wabash Ave.
IOWA
Des Moines—117-119 Fifth St.
Dubuque—8th and Washington Sts.
Ottumwa—207-9-11 S. Washington St.
Sioux City—925 Fourth St., P. O. Box 398.
KANSAS
Pittsburg—109 W. Third St.
Salina—154 So. 5th St.
Wichita—721 Beacon Building.
KENTUCKY
Louisville—126 E. Main St.
Middlesboro—
LOUISIANA
New Orleans—819-21 Julia St.
MAINE
Portland—202 Commercial St.
MARYLAND
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
Salisbury—Opp. Fulton Station.
MASSACHUSETTS
Boston—(See Cambridge "A.")
Cambridge—241 Albany St.
Springfield—Napier St.
MICHIGAN
Detroit—3rd and Holden Aves.
Grand Rapids—500 Shawmut Ave., N. W.
Hancock—First National Bank Bldg.
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Insist on REGO Welding Regulators

Adopted by most leading manufacturers.

Proclaimed the best by experienced welders and competent engineers.

Stoutly built for hardest service.

Unsurpassed for range and fineness of adjustment, accuracy, strength and reliability.

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Every detail of their construction is the result of careful thought, thoroughly tested and skillfully executed.

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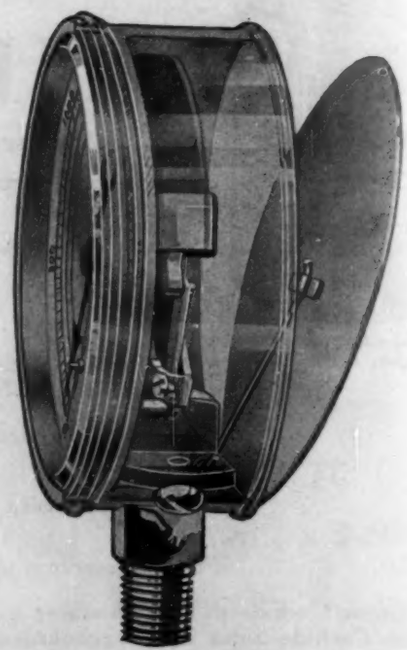

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for

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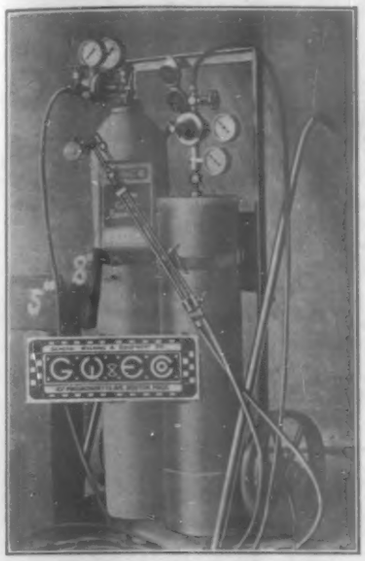

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Consisting of:

Oxygen Regulator of the double diaphragm type with forcibly guided seat; with 2 gauges and check valve outlet which prevents explosive mixtures from entering the regulator body. High pressure gauge with solid front and safety release on back. (U. S. Government standard.) Acetylene regulator of similar construction. Cutting Torch with 4 interchangeable tips and a pair of guide wheels (several thousands of these cutters sold within the last 18 months). Two lengths of high pressure hose, 25 ft. each, Goggles, Wrenches and Instruction Book, all packed in steel box.

An Equipment which forced its way into the most prominent concerns by reason of its fine points of construction and its practical efficiency.

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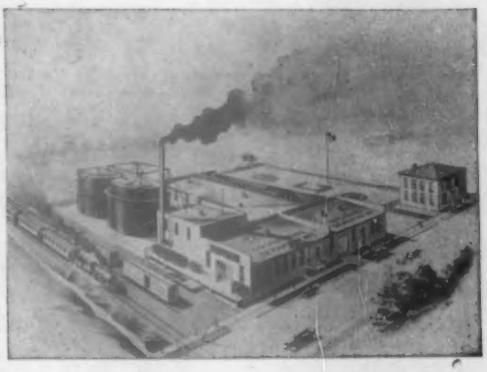

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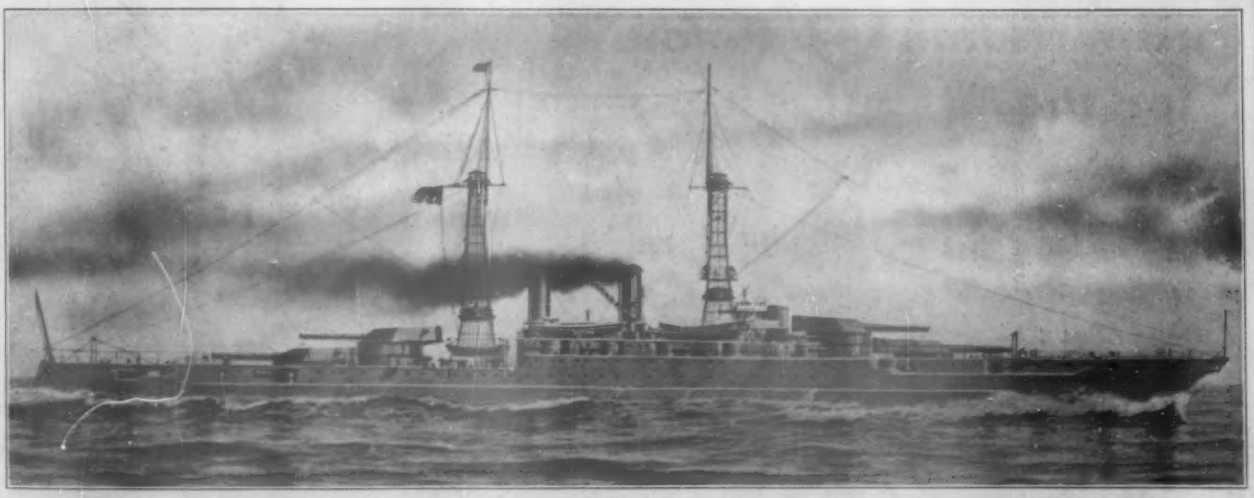

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Willis welding and cutting torches are to the welding trade what the "Colorado" class is to the Navy—the very last word. Efficient and dependable.

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Thomson Process Electric Welding

The 15-A Welding Machine is designed for welding heavy automobile rims. All parts are necessarily made massive and substantial in order to prevent trouble and give continuous service. The rim to be welded is placed in the specially constructed vertical clamps which are locked by a series of hand levers. Current is turned on by a pedestal foot-operated switch, and the metal becomes heated. Welding pressure is applied by the 25-ton hydraulic ram, and the current turned off. The welded rim is then removed from the clamps.

Write for Butt Welding Bulletin No. B-5.

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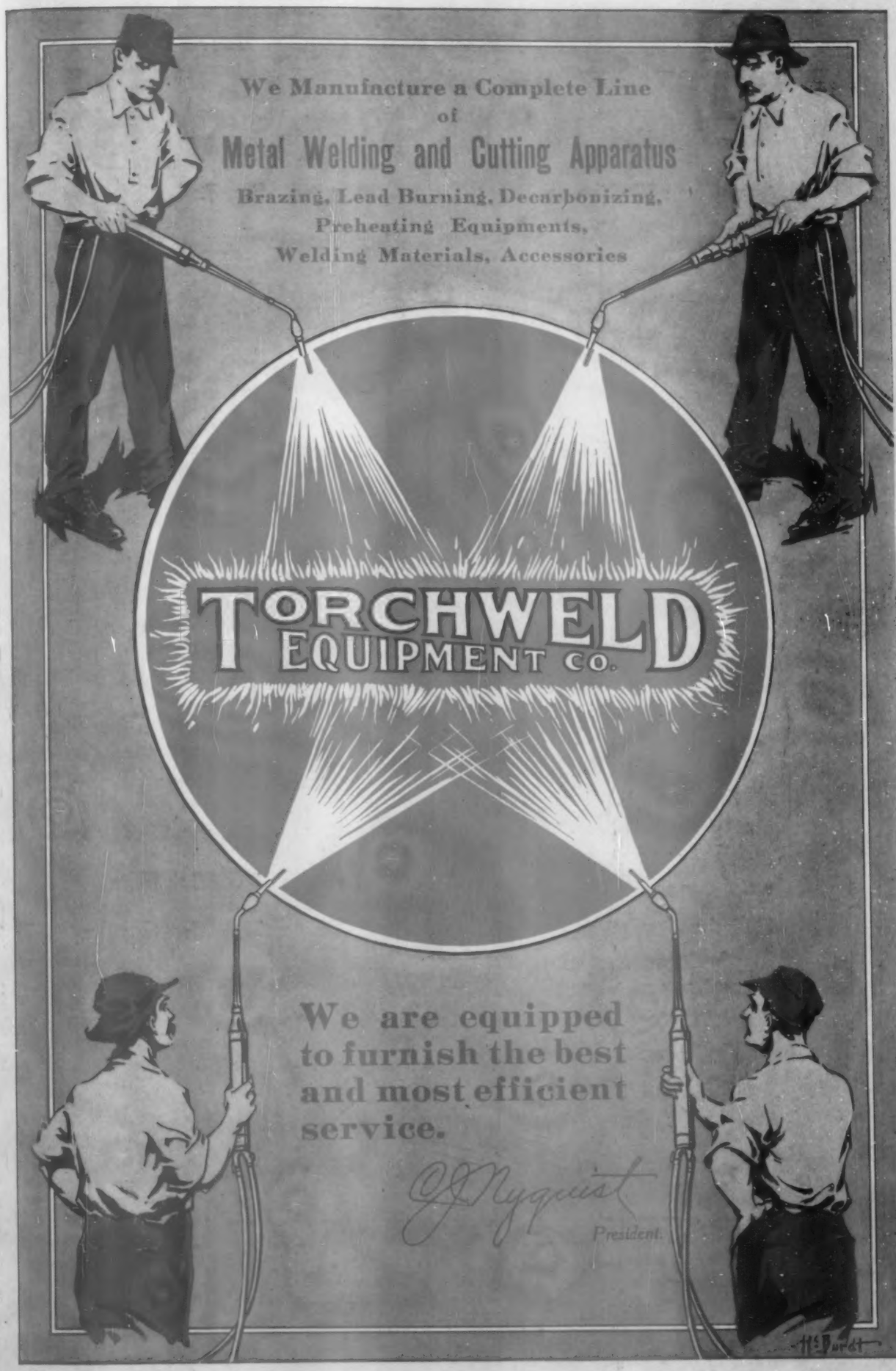
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The Pull-U-Out Portable Crane

The Most Remarkable Portable Crane on the Market

It weighs only **250** pounds and has a lift of **9 feet 6 inches**, and a lifting capacity of **1 ton.**

It is built of 2½ inch extra heavy steel tubing, enameled black. Slip jointed and can be put together in 5 minutes with an S-wrench. It is built so that the weight cannot tip it over. Base is 3 feet 3 inches wide by 6 feet deep. Total height is 10 feet.

It is mounted on strong roller wheels, and will do the work of an entire system of overhead tracks and do it better, because it can go wherever there is a floor to roll it on.

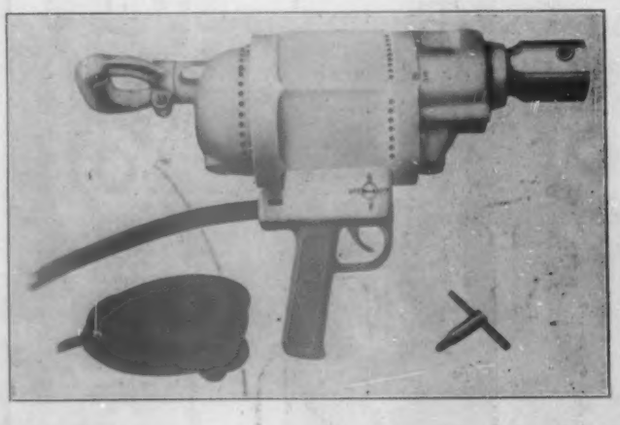
The Pull-U-Out Portable Crane solves the problem of hoisting and transporting heavy objects from one part of the shop to another.

The Pull-U-Out can easily be detached from the crane and used separately for all manner of hoisting or pulling, making the outfit valuable in many ways other cranes are not.

Shipped ready to put together. Price, complete, with Pull-U-Out, $50.00, f. o. b. St. Louis, Mo., or Cleveland, Ohio.

How Many Times Has This Happened to You?

Ever try to drill a hole in some hard-to-get-at place, your wrists numbed with fatigue? And just as the drill went through, the drill bit snapped because you had to let go to reach the switch.



The B. & D. "Portable"

The Drill With the Pistol Grip

does away with that trouble. You keep hold with both hands and simply pull the trigger to control the current. And the pistol grip holds the "gun" naturally and easily. Universal motor, ball thrust bearing, chrome-vanadium steel gears. Welders will find this tool well adapted to work in the welding shops.

SAVES DRILLS

In designing this model, especial attention has been directed toward the prevention of breakage of small drills when operating the switch (a source of annoyance and loss with other designs.)

It will be seen, by reference to the illustrations, that the control is that of the automatic pistol, one finger doing the work without in the slightest affecting the steadiness of the aim or the firmness of the support of the tool. There is no releasing of the grip to turn the switch or press a button, or push in or pull out a handle at the moment the drill breaks through.

You simply pull the trigger without the slightest wavering of the tool or sagging of the weight, and consequently the drill is stopped without breaking the drill bit.

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THE K G TORCH

It is a well established fact that the **"torch"** is the most important unit of an oxy-acetylene welding and cutting equipment.

The K-G Torch has a reputation in the trade which speaks for itself. We will gladly demonstrate the torch at any time and we guarantee it to be equal to any and better than most on the market today. Finally, the price will leave no argument open.

The Complete K-G Welding and Cutting Equipment is in every detail as reliable and efficient as the K-G Torch. All K-G supplies are guaranteed to be the highest quality goods.

Torches, Regulators, Hose, Gloves, Gauges, Goggles, Welding Rods, Wire and Flux, Oxygen, Acetylene and Blau Gas.

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A Portable, one-man torch, weight loaded 25 lbs.

Burns in any position. Gives a roaring flame 24 inches long, for one hour on one gallon of kerosene.

You Need This Torch

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L. B. MACKENZIE, Editor

The Welding Engineer

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Welding quality in iron or steel is conferred by the ferrite (pure iron) content. Carbon, Manganese, Oxygen and their compounds are harmful impurities because they make possible the burning of the metal in the process and also because they rob it of physical evenness.

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"ARMCO" Iron is rapidly taking the place of imported wrought iron for welding purposes. It is well adapted to any welding process.

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Straight Lengths and Coils

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Investigate Arc Welding

Are you in a line where steel or other metal pieces must be joined to make the completed product?

If so are you absolutely sure that your present method of doing this work gives you as good a product and as low a cost as arc welding?

The Lincoln Arc Welder

is now being used by hundreds of manufacturers who had "never thought much about it" or had jumped to the conclusion that arc welding, while all right for some things, would not do their particular work.

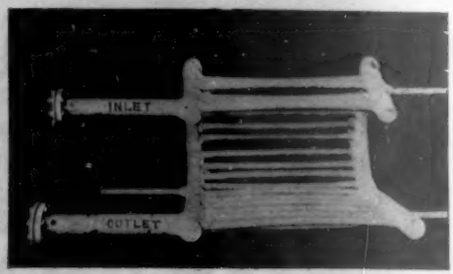
These firms, our engineers have had to seek out and convince by practical demonstration—but they lost money every day they waited for the engineer to call.

Why **wait?** Write now for our engineer, put your problem before him. It will not cost a cent and arc welding will not be recommended unless we can actually demonstrate a saving that you consider worth while.

Ask for Bulletin 50-L

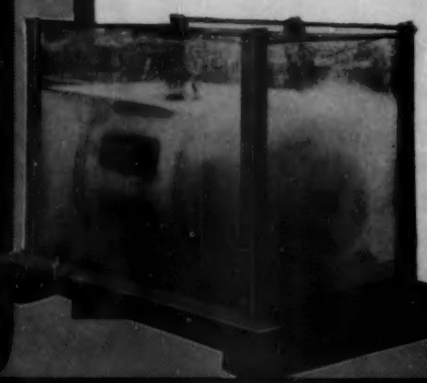
Tee connection formed by welding two pieces of pipe with Lincoln Arc Welder.

Cement Kiln formed by welding long, vertical seam in boiler plate with Lincoln Arc Welder.



Steam Superheater, with every joint welded with a Lincoln Arc Welder. Not a single rivet in the construction.

Manganese steel cross over for street railway. Low spots repaired with Lincoln Arc Welder.



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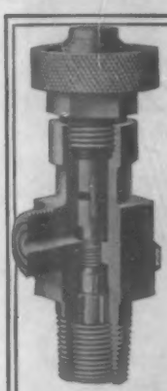

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Thermalene Producers

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The second, we can aid you in by supplying the proper blowpipe for preheating purposes.

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Metal mines have boosted output to meet world-wide demands. Great central power plants in place of small local plants in coal mining areas now supply cheaper electric power per ton output for each mine. All tonnage records have been smashed in the steel industry. Greater automobile output has lowered prices and given better road transportation. More and better cloth has been produced at lower power costs.

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Any problem involving the use of power can be simplified by the application of electricity. The General Electric Company is well equipped to lend valuable assistance in working out such problems and is glad to co-operate with manufacturers and engineers in every possible way.

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CARBO-HYDROGEN burns with a clean flame and gives off no noxious fumes, and can be readily used in all confined places. It is a true combustible in every sense of the word and in nowise explosive, and, undoubtedly, is the safest gas to use.

CARBO-HYDROGEN is superior to use on all classes of cutting, cast iron welding, aluminum welding and brass welding. In welding, an utter absence of blowholes is noted and the welds are left soft and nice so that they can be readily machined. This is a large advantage where welds must be machined after being made.

CARBO-EQUIPMENT has been designed along scientific lines and no guess-work has been used in any portion of the apparatus put out.

CARBO REGULATORS are undoubtedly the most correct and dependable on the market.

CARBO HOSE will stand the greatest pressure with the longest life.

CARBO CUTTING AND WELDING PIPES are scientifically correct in every detail, with the theory of combustion taken care of perfectly.

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Get an Oxy-Acetylene outfit. But be sure it is a Vulcan. It is much superior to any other, less costly to operate, more complete—more capable—for no job is too big or too little for it to do perfectly.

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Linde

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MISCELLANEOUS USES *for the* OXY-ACETYLENE TORCH

By David Baxter

Manufacturing.

The oxy-acetylene welding and cutting plant opens a wide field for manufacturing in the small towns. It is capable of doing work that formerly required expensive machinery; it is in itself several complete machines. With it all kinds of steel or wrought shapes may be cut out and then welded together. Pipes and tanks of all kinds and shapes may be made. Metal furniture, camp stoves, wheel barrows, garbage cans and furnaces and kitchen ware, etc., can be made a great deal better and stronger than any bolted or riveted kinds.

Local conditions, freight rates and various other things often influence the sale of home-made articles. With an oxy-acetylene apparatus the small manufacturer can often turn out certain articles as cheaply as the larger concerns, on account of not having a big sum invested in buildings and machinery.

It seems that the European wars should have the effect of opening a large market for the sale of metal toys and novelties. Also other metal articles formerly made in Germany and other countries. The owner of a welding plant may just as well take a hand in this even if it is on a small scale.

An opportunity is also offered to the welder to manufacture numerous articles from old junk steel and wrought iron; such articles as metal ladders and fire escapes, fence posts, cement rammers, hog troughs, poultry fountains and an endless variety of articles in every line of endeavor. These things may be made of old junk or new metal according to conditions or requirements.

Removing Scale.

Another use for the welding outfit is in the removing scale from boilers, vats, flues, etc. This method is not only faster, but can not injure the boilers, as is possible when cracking scale with hammers.

The method employed is to pass the welding flame over the surface of the scale, heating it and causing it to expand, while the boiler remains cool. The unequal expansion of the scale and metal will cause the scale to crack and drop off in large sections. The same is true in removing heavy rust from metal articles.

As A Carbon Remover.

The oxy-acetylene torch can be used to a great advantage in removing carbon from cylinders, pistons and other things which carbon is deposited on. Take for example an automobile engine. It is only necessary to remove the valve covers and bring the pistons to the top firing position. Ignite a small bit of oily waste, or a very short piece of candle, and drop it into the cylinder. Then direct a stream of oxygen on the flame of the bit of candle or waste, after getting the flame in contact with the carbon on the wall of the cylinder. The oxygen will combine with the carbon to cause a fierce little fire which entirely consumes the carbon.

Follow the burning carbon around the cylinder with the stream of oxygen and it will be evenly burned out as clean as new. The heavier the deposit of carbon, the more readily will it burn. If the deposit is light, it is sometimes necessary to dampen the carbon with a small amount of kerosene oil before turning on the oxygen. This makes the carbon ignite easier; frequently it is difficult to start the light deposits to burning.

The oxygen pressure for carbon burning is from fifteen to twenty pounds; not over that. The ordinary welding torch can be used to remove carbon, but a special torch is made for the purpose. Do not use the welding flame; only the oxygen. Use an extension tip if the torch is employed.

Removing Caulking.

Another use for the torch is to remove the caulking from the joints in water mains. This is a slow and tedious job by other methods; it is difficult because the work is usually located at the bottom of a ditch frequently six feet deep and very narrow.

By using the oxy-acetylene torch the process is simplified. The operator takes the torch down into the ditch and directs the flame between the bell and spigot ends of the joint. These joints are usually packed with waste or oakum backed by melted lead. In removing the caulking the waste is burned out, and the lead melts and runs out of the bottom of the joint.

By arranging a small pool in the sand to catch the melted lead all of the lead may be saved. The melting is started at the bottom and worked up half-way round the pipe. It is then started at the bottom again and work around the other half. In this way the lead is always kept flowing downward and does not hinder the operation.

The melting point of lead is so far below that of the iron pipe that there is no danger of melting the pipe. The tip of the torch is pointed downward as near as possible to throw the flame away from the tip. This places the tip in no danger of overheating. No flux or other artifices are necessary on this kind of work.

Hardening Wearing Parts.

The welding torch may be used to harden the wearing parts of machinery. It is used in hardening gear teeth, castellated shafts, template holes and so forth. It is employed to advantage where the ordinary case hardening would cause distortion.

The essential feature is the quick transit of the flame over the spot to be hardened so that it may be raised to the correct temperature and then rapidly cooled.

Any of the high tensile steels may be hardened to a depth of about one-sixteenth of an inch. The hardness causes brittleness; but it is only the surface, the balance of the casting remains as strong as ever.

The parts not being hardened are kept as cool as possible, by water poured over them or by wet cloths wrapped around them. The torch is held so as to cause the flame to travel ahead of the hardening. The portion of the work passed over by the flame is cooled according to the degree of hardness desired. If intense hardness is wanted, the heated part is cooled immediately with cold water. For medium hardness, the cooling is done more slowly. The hardening heat is straw color in the heated casting.

The flame should always be as hot as possible when case hardening. The heat of the neutral flame may be increased

by increasing the oxygen until the neutral white cone changes to a bluish one; it appears to be a bluish tongue, streaked with white, when observed through smoked glasses.

A good way to obtain an intensely hard surface is to arrange to have the place to be hardened just below the surface of water. The water should flow over the spot in a thin film. The pressure of the flame will blow the skin of water away while the metal is heating. As soon as the torch is removed the water will immediately close over the heated spot. A glass-hard surface may in this way be applied to steels, cast and malleable iron.

The surface hardening may be explained in this way: The heating of the metal causes it to expand, and the sudden cooling causes it to contract beyond its initial state. The grains of metal are squeezed together in such a way as to form a smooth, hard surface.

The more rapidly the heat is raised and the more rapidly cooled, the greater will be the contraction, resulting in finer grains more closely knit together, causing a corresponding hardness.

If the parts heated were allowed to cool normally, the grains would be very little smaller than before heating. If the parts heated were banked or covered with warm sand, thereby retarding the cooling, there would be scarcely any change in the grains or the hardness.

Straightening Crooked or Warped Pieces of Cast Iron.

Another neat little trick with the oxy-acetylene blow pipe, is the straightening of warped castings; such as thin sections of stove plate. Take for instance, one of the thin strips of iron used in the draft control on heating stoves. These strips sometimes warp and cause lots of trouble. They may be straightened by weighting down or by tightening in a vice. In the first instance, place the casting with the arch up. Then put several pounds of weight upon the arch and play the welding flame back and forth over the under side, near the center of the arch. Bring it to a bright red heat. As the heat increases the casting will straighten, if the weight is sufficient.

With the vice method, we have to be very careful and use nice judgment, when and how much to screw up the vice. Do not set up the vice until the casting is very hot and then do it very slowly, a part of a turn at a time. Allow the casting to remain in the vice till cold.

Some castings in a slight twist may be bolted in shape cold, heated all over and allowed to cool slowly.

An ingenious torch operator will have no trouble inventing other ways of straightening crooked castings.

Welding Leaky Metal Barrels.

Every operator should be cautioned about welding up the leaks in metal barrels that have been used to ship any kind of oil or gasoline. There is danger of causing an explosion by heating the barrels. The heat from the torch causes gas to generate from any quantity of oil that may remain in the barrel, even thick crude oil that may be adhering to the sides of the barrel. Several severe explosions have come to the attention of the author.

A number of these barrels may come to any repair shop to be repaired, at any time and the torch operator will do well not to try to weld them, without taking some precaution. These barrels have from one to a half dozen very small leak holes in them.

The best way to avert danger of explosion is, to first fill the barrel with water, then stop all of the leaks but one with pieces of rags. Now turn the barrel so the one hole is upward. Be sure the barrel is full of water, with exception of about an inch and a half directly under the hole. This leaves such a small cavity for the gas to form in that there is no danger of it exploding. Now weld a small spot weld on the hole and roll the barrel around to the next one, and proceed in a like manner. The smaller air space we can have under the weld the less is the danger of explosions.

NEW WELDING INSTITUTE.

An important announcement has been made by the Davis-Bournonville Co., of Jersey City, concerning the "Davis-Bournonville Welding Institute," for instruction in welding and cutting with oxy-acetylene and oxy-hydrogen. In connection with the plans of the company we quote as follows from the circular announcing the institute:

"There is great need for competent instruction in the oxy-acetylene art. Scientific inspection has demonstrated that even those who have become considered experts through self-education has failed surprisingly and lamentably under essential tests.

"We are entering an era in which welding will not only be applied to the repair of breakages and to work of a nature in which strength is not of extreme importance as in the past, but will be applied extensively under conditions where strength is of vital importance, and where the elimination of the variations in the human factor is absolutely necessary. It will be necessary for the welder, and those who use his services, to know positively how far the strength of his welds are to be relied upon, and this can only be done by laboratory methods of instruction and analysis of performance.

"One great defect in promoting the art has been indifference in the selection of men to learn the use of the apparatus. There has been too much assertion that the process is simple and a wide-spread belief that no special talent or intelligence is required of an operator.

"While it is true that there are ordinary laborers who can be taught to do certain welding where the operation is one kind and continually repeated, our contention is, even in such cases, that the deftness and intelligent application of a higher mentality will not only produce better results but perform them more economically.

"In accordance with this belief we have planned our institute for the instruction of students who not only have the ability to perform mechanically, but the mental comprehension, as well, to grasp the principles on which the art is based. With students of this character we may hope to soon put the industry upon a much higher level and to provide real experts to manufacturing concerns that are now handicapped by lack of correct information.

"One of the great difficulties in the way of mechanics and others of a higher mentality becoming welders is the time necessary to become proficient in the art, which, when the wages of the learner is considered, makes the cost almost prohibitive.

"One of the objects of this institute is to reduce the time necessary to become proficient in the art to a minimum, using carefully thought out methods of instruction intensively applied. To accomplish such an object there must be ample facilities and tutors of very exceptional ability.

"As to the facilities, we have equipped a floor in one of our buildings with welding and cutting apparatus, both for hand and automatic use, machine for testing welds to 100,000 pounds, meters for measuring gas under pressure, appliances for determining proper speeds for cutting, and apparatus for chemical tests. In addition to this we maintain a large welding shop where practical work of most every character is being constantly performed, affording to pupils the opportunity of witnessing actual commercial operations on a large scale. To a reasonable extent students will be permitted to see the various parts of apparatus being manufactured, assembled and tested, and thus becoming familiar with the various parts as well as the completed apparatus.

"The institute will be under the supervision of Mr. Henry Cave, technical director for the Davis-Bournonville Co. The following is a brief biography of Mr. Cave taken from the 'Engineering Magazine,' July, 1916:

"'Born at Nottingham, England. Educated at the high school and Nottingham University. Apprentice to E. Reader & Sons, engine builders, of that city. Served as engineer with the Daimler Motor Co. and the Motor Mfg. Co., Coventry, England. In 1900 became associated with the Riker Motor Vehicle Company; mechanical expert on the Selden Patent Case; served as engineer to the Electric Vehicle Co. and the American Locomotive Co. (automobile department). Formed the Cave Welding & Mfg. Company, of which he is the president, in 1908.'

"He was the dealer for the Davis-Bournonville Company in the New England States for eight years, and during that time established and operated six welding shops, so that he has wide practical as well as theoretical knowledge, and is prepared from every standpoint to supervise such an institution.

"Mr. Cave has made careful selection of his assistants, who are not only engineers of considerable practical experience both in mechanical lines and in handling men, but also are experienced instructors, thus being familiar with the best methods of imparting instruction in the shortest time. He has personally instructed them in methods of operating the equipment, which have proved, by extensive test, to be the best both from the point of view of economy and results obtained.

"Through the continuous efforts of the company, new developments of much importance in the art have been accomplished, especially in the last few months, and it is our desire to impart to the industry the benefit of the knowledge acquired. This can be done most quickly and effectively through a high class of intelligent, earnest, skilled operators. To secure capable students and educate them to operate by correct methods is the object of the institute. It is our desire to make a diploma from the institute an assurance of employment to the holder wherever his services can be used, and this can be accomplished only with the best material and expert instruction.

"It is our intention to make the Davis-Bournonville diploma something that can be depended upon, and therefore completing one course does not necessarily mean the winning of a diploma, which will only be given for actual results. A certificate, however, will be given in all cases showing that the bearer, whose photograph will be attached, has taken the prescribed course.

"As it is necessary for intensive methods of instruction to be used and results can only be attained by carefully following instructions, the student must place himself under our control during the hours of instruction. It should be realized that these conditions necessarily result in a good deal of monotonous practice, and the student must be prepared to submit to this for the short duration of the course.

"To become proficient in this art, a large amount of oxygen, acetylene, metals and other supplies will be consumed. For this, together with the elaborate equipment and high grade instructors and supervision necessary, a substantial charge must be made; and in considering this it should be realized that those bearing the expense of the instruction of welders by any method, even including the free instruction given by manufacturers with the purchase of equipment, must bear this cost or more, though it may be spread out in an unnoticeable manner while the subject is acting as helper, and will loom very large when the cost of the time and gas used in excess by the beginner on production work is taken into account, without considering spoiled work and poor results.

"The classes will be held at the Jersey City factory of the Davis-Bournonville Company. We reserve the right to select our students, and attach application form which must be filled in. We will assist students in finding suitable rooms and board in the neighborhood of our plant, but take no responsibility in this matter.

"We would suggest that employers can arrange an indenture with their employees whom they wish to take the course for which they will pay, the indenture to bind the learner to their service for a sufficient length of time to repay them for the expense. This, however, may not be necessary in a large number of cases. We especially recommend employers to select their students from men whom they have known for some time, and of a class which they could eventually make foremen, and who having taken the course should be able to instruct routine welders. Each student will be allowed an opportunity of trying out equipment of the principal makes on the market.

"A copy of 'Text Book of Autogenous Welding and Oxygen Cutting,' by Henry Cave (in the press), will be given to each student."

Application for Davis-Bournonville Welding Institute

Name..... Date.....
Address .....
Occupation .....
What particular part of this work are you engaged in.....
.....
In what capacity.....
What previous experience have you had.....
Education. State if you graduated from Grammar, High School, Technical School, Trade School, Night School, Correspondence School or College, where and how far you went in any of these.....
.....
.....
Have you had any experience in welding or cutting? If so, state in detail where and how much.....
.....
.....
State what is your object in taking the course and what branch you wish to take up. WELDING—Manufacturing, Repair Work, Machine Welding; any particular form of Metal, Sheet Steel. CUTTING—Cutting for general use for Wrecking, Accurate Work, Machine Work.....
.....
.....
Course No. .....
If my application is accepted, I agree to follow, to the best of my ability, the instruction given and to place myself, during the period of the course and the hours of attendance thereof, entirely under the control of the instructors.
Signed.....
My course will be paid for by.....
.....

COURSES

1—Instructions for experienced operators, one week....$100.00
2—Instructions for superintendent, foremen and students of exceptional ability, two weeks..... 150.00
3—General course of instruction, four weeks..... 200.00

When heavy cutting is required, a reasonable charge will have to be made for materials and gases.

Additional courses will be made from time to time as developments require.

Terms:—When paid for by student, payment in advance; otherwise by arrangement.

NEW IMPERIAL CATALOGUE.

A handsome new catalog has been published by the Imperial Brass Manufacturing Co., 1200 West Harrison Street, Chicago. A feature of the new publication is the full description of the new Imperial lead burning equipment. Welding and cutting torches of all patterns are described, as well as parts and accessories, regulators, decarbonizing equipment, goggles, gloves, trucks, etc.

The Imperial Welding and Cutting Hand Book is also advertised. This book contains 60 pages of compact and readable suggestions for the welder. It is sent free to users of Imperial equipment, but is sold at $1 per copy.

A DAY'S WORK *in a* RAILROAD WELDING SHOP

By B. Kopferschmidt

On a hot summer's morning before the whistle blew, the men employed in the acetylene welding shop, were sitting around the large welding table, enjoying the last smoke; they discussed about the best bait for trout; about the heat of the sun; blow pipes and the preheating ovens.

One of the men wished that he may get smaller jobs where preheating will not be necessary; another one hoped that he would not get any boiler welding; a third one remarked that the jobs all seemed to be just like the days, always going by; yet another one wished that we would not get any big jobs at all.

A few feet away the foreman sat at his desk and on hearing the above discussion, he made up his mind to record all the big jobs that would be performed on that day and to let the readers of this paper have an idea of a day's work under a temperature of 93 above in a welding shop.

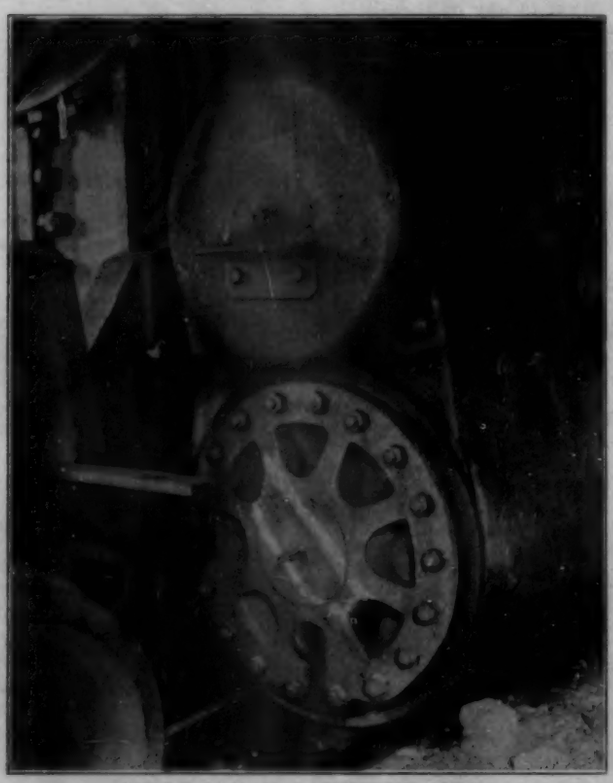


Fig. 1. Cylinder Head Welded. Cost of Welding, $3.75. Cost of a New One $14.55.

Fig. 2. Locomotive Cast Steel Frame, 14 in. x 6 in. Cost of Weld $28.00. The Cost of Taking Off and Welded in the Blacksmith Shop is $200.00.

The following jobs made up the day's work:

The shrill sound of a whistle announced to the men the beginning of the day's work.

The first job was to weld a ¾-inch flue sheet in a locomotive boiler, one welder and a helper took care of this order in 2½ hours. The cost of this weld was $3.75, and if a new flue sheet would be set in by the boiler makers it would have cost $85.

Fig. 1 shows a cast iron cylinder head, about 14 inches long, welded at the center. The crack was beveled to a 45-degree angle and preheated in a charcoal oven for about two hours; then with the aid of a long-handled blow pipe, the welding was performed in one hour by one welder, at a cost of $2.40. A new cylinder head would cost $14.55.

Fig. 2 shows a locomotive cast steel frame 18 by 6 inches; this was the heaviest frame ever welded in our shop. This locomotive could not be kept in the round house very long, so we decided not to do the regular stripping and the wheels were left on the engine. Therefore, the welding was performed from the inside of the pit, and only one operator could work at a time. After the frame was expanded ⅞ inch and preheated to a dull red, two men by relieving each other, welded this frame in 14 hours at a cost of $28. If this frame were removed from the engine and welded at the blacksmith shop, the cost would have run up to $200 plus the delaying of the locomotive of another week from service.

Fig. 3 shows a cast iron front end of a locomotive that broke in a collision. The round house foreman thought to scrap this casting and put a new one on, but he was unable to get a new one from stock, so in order not to hold the

Fig. 3. Cast Iron Front End. Cost of Welding $4.50. Cost of New One $22.50.

engine out of service we were requested to weld it. After the fracture was beveled, one man welded it up while another man with the same size blow pipe heated the casting opposite the fracture so as to obtain an equal contraction, and also to save preheating of the whole casting. Around the smoke box door opening pieces were broken off; therefore, it was necessary with the aid of a carbon paste, to build a sort of dam and then fill it up with cast iron; when the weld was completed, machining was not necessary. One

Fig. 4. Low Pressure Locomotive. Cost of Welding $16.00. Cost of New Cylinder, $900.00.

Fig. 5. High Pressure Locomotive Cylinder Before Welding. Cost of Welding, $20.00. Cost of New Cylinder, $800.00.

Fig. 6. High Pressure Locomotive Cylinder After Welding.

Fig. 7. Low Pressure Locomotive Cylinder Before Welding. Cost of Welding, $25.00. Cost of New Cylinder, $900.00.

Fig. 8. Asbestos Suits to Protect the Welders from the Heat.

welder and a helper was engaged on this job 3 hours at a cost of $4.50. A new one would have cost $22.50.

Fig. 4 shows a low-pressure locomotive cylinder welded between steam chest and saddle. After removing the frame, the 3-inch crack was beveled to a 45-degree angle, and after the cylinder was preheated, two men welded it in 8 hours, at a cost of $16. A new cylinder would have cost $900.

Fig. 5 shows a high pressure cylinder, broken at the port holes. Four cores were made of carbon paste to correspond with the size of the original port holes, and set at the four fractured holes. When the cylinder was preheated the cores dried and expanded in the casting just as hard as a carbon block. The method of welding this cylinder was the same as the one published in the July issue of this paper, page 21. Time required to weld this cylinder was 11 hours, and two welders and a helper were engaged on this job at a cost of $20.75. The cost of a new cylinder is $800.

Fig. 9. Low Pressure Locomotive Cylinder After Welding.

Fig. 6 shows the same cylinder after welding.

Fig. 7 shows a low-pressure locomotive cylinder with an 8-inch square piece broken off at the bottom, and a crack extending about 26 inches. After the fractures were beveled as usual, the square piece was tacked in its place, and a brick furnace built around the cylinder and preheated for 5 hours. Although long-handled blow pipes were used, the heat was so intense, that it required the two welders engaged at the welding, to wear asbestos suits as per Fig. 8. Time required to weld this cylinder was 12 hours, at a cost of $25.40. A new cylinder would have cost $900.

Fig. 9 shows the same cylinder after it was welded.

In addition to these jobs, we had a great many smaller welding and cutting jobs of more or less importance and we finally got through about 9 P. M. At the washroom the first welder commented, that this was "some day," but the third welder remarked that all the jobs, big and small, seemed to be just like the days, always going by.

CUTTING SCRAPS.

By T. E. Sturman.

I have been cutting heavy steel scrap, also doing heavy welding exclusively for the past five years and having had about twelve years' experience with electric arc welding and at present am employing nine electric cutters and four oxy-acetylene cutters, and find that the most profitable and economical way of cutting scrap is by the electric arc.

I have cut scrap at far less than it would cost per ton to cut with oxygen alone, that is to say, furnishing electric

Army Welders on the Mexican Border.

current at 1½ cents per kilowatt hour and labor at $4 per day, can cut steel scrap, steel, cast iron, manganese or any other hard cutting scrap at cheaper rate than oxygen could be furnished without labor, gas or equipment.

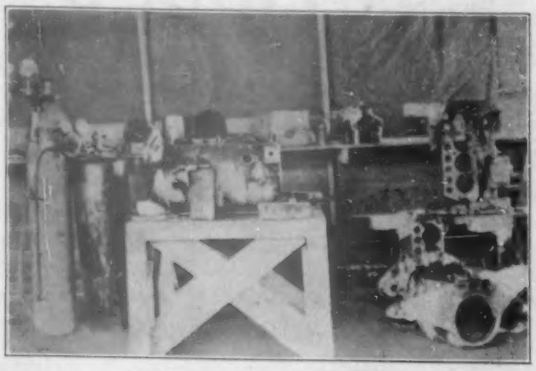
This might be interesting to the four thousand readers of *The Welding Engineer*. I have seen some articles in your paper where the electric welding has always been given the disadvantage and before a man writes on a subject, he should know what he is talking about. A man that knows what he is writing about always comes out to be understood. The facts, figures and good work are the whole thing which the welding game consists of.

In welding heavy work such as rolling mill machinery, locomotive frames, street railway work and dredging work, by experience which I have had, the electric arc cannot be outclassed. The metallic electro welding is excellent for

First Class Auto Mechanics Are Needed by the Army.

boiler work, but for heavy section, I would prefer to make a weld by the carbon arc and can make a weld in 50 per cent less time at 50 per cent less cost. On tank work metallic electro process should be used exclusively, but I know of one firm in particular whom have for twenty-two years used nothing except the electric arc for building large steel tanks and welding large, heavy sections into pipes with the greatest success and efficiency.

So I would suggest before anyone gives the oxy-acetylene welding all the highest honors, he should give the arc welding a little consideration and give credit to it where it is due. I believe the time will come and not very far away, when the oxy-acetylene welding will be done away with and the arc electric welding will be standard and the



Trucks and Other Cars Must Be Kept in Service. Welding Plays An Important Part.

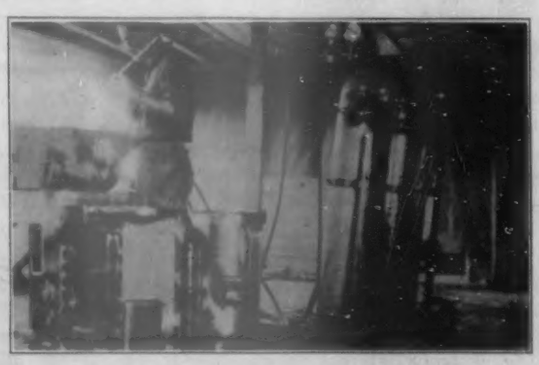
only welding considered. We cannot compete with progress, and electricity is the mother of progress, so anything that can be done, I would advise our readers to do it electrically.

GERMANY'S SUPPLY OF BRASS AND COPPER.

The extent to which Germany is increasing its supply of brass, copper and other metals is illustrated by the testi-

An Army "Welding Shop."

mony of a wounded British soldier on furlough at home. Referring to the large amount of old metal waiting to be gathered up after the war, he said it would be chiefly steel, for the Germans appear to be collecting the brass in thorough fashion for remelting. In several captured German trenches



These Five Views of Army "Welding Life" Were Secured Through the Courtesy of Mr. H. A. Lindholm.

and dug outs he had seen little canvas bags partly filled with broken fuses, nose caps and other brass scrap, indicating that this method of collecting is being systematically carried out by the enemy.

OXY-ACETYLENE WELDING *of* COPPER, BRASSES *and* BRONZES

By M. R. Amedeo

Metallurgical Engineer to the Union de la Soudure Autogene. Translated, with additions, by D. Richardson, Wh., Exh., A. M. I. Mechanical Engineer, Member of the Union de la Soudure, Autogene.

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Introduction.

At the present time the oxy-acetylene welding of copper and its principal alloys is not widely practiced. The majority of work shops that have been utilizing the process now for several years for the welding of articles made of iron, steel or cast iron hesitate in extending the use of the blow pipe for the construction or the repair of articles made of copper, brass or bronze.

This diffidenece is, in a measure, retarding the development of copper welding, and is mainly due to the very poor results obtained by oxy-acetylene welders who attempt to weld copper plates.

Many welders, astonished at the ease with which they obtain sufficiently strong weld on mild steel, attempt to weld copper and its alloys by utilizing the same methods. For example, they use as a welding rod a strip of metal cut from the plate itself, or a wire of the same nature, with the result that the welds obtained by these simple methods are of little practical value. Skillful manipulation of the blow pipe alone is insufficient for producing strong welds, because copper melted by the flame of the blow pipe is no longer pure. The added metal—in other words, the welding rod—should contain elements capable of preventing defective welds due to changes in the metal of the joint, and the autogenous welding of copper and its alloys is only possible when a welding rod specially made for each metal or alloy is used.

From time to time heterogeneous alloys under special names have been proposed for the welding of copper, usually by individuals incapable of appreciating the distinction between a real autogenous weld and a mediocre brazed joint.

The composition of several of these mixtures will be examined later on, and will suffice to show the grave error in making use of them. Failures, following the use of these mixtures, have largely been responsible for the belief that it is impossible to obtain perfect welds on copper and its alloys.

In addition to the deplorable results obtained by using these "special" metals, which, as already mentioned, give distinctly inferior results to those obtained with ordinary brazing, it is of interest to examine the resistance offered by parts welded with metals manufactured specially for supporting, without alteration, the melting with a blow pipe. The results of tests which are given later demonstrate once again that the best method of obtaining encouraging results in oxy-acetylene welding is to apply in a rational manner a method of work scientifically established.

Oxy-Acetylene Welding of Copper.

Physical and Chemical Properties.—Copper stands alone among the metals in having a reddish color. The brick-red tint observed in the fracture of certain commercial coppers of bad quality, and also in many welds, is due to the presence of appreciable quantities of oxide in the interior of the metal.

The specific gravity of copper is about 8.9; its melting point is about 2,000 degrees F. (1,100 degrees C.). Copper is an excellent conductor both of heat and electricity. Owing to its high heat conducting power it is used for fire box plates and similar purposes, and this property, from a welding point of view, is a great disadvantage. The rapid conduction of heat from the part played on by the blow pipe frequently leads to the defect of adhesion instead of welding, and thus every precaution must be taken to combat loss of heat, which sometimes completely prevents melting of the metal and always increases the time taken to do the weld.

The high conductivity for heat of copper slows down the cooling of the lines that have just been welded, and this increases the possibilities of fracture, because the tensile strength of copper in the heated condition is very low. The following figures due to Bengough show the effect of temperature on the tensile strength of copper:

Temperature of Test. Degrees Centigrade.	Degrees Fahrenheit.	Maximum Stress. Pounds.	Tons per square inch	Elongation per cent on two inches.
17	83	1,800	16.3	32.5
252	486	1,393	12.7	28.0
330	627	1,197	11.0	29.6
420	788	1,043	9.5	28.3
480	896	823	7.5	27.5
540	1,004	570	5.1	27.0
620	1,148	287	2.6	27.0
675	1,215	169	1.3	28.4
736	1,357	141	1.2	36.0
840	1,544	105	0.96	61.0
920	1,770	60	0.50	69.0
1,010	1,850	21	0.16	38.0

It will be noticed that the strength of copper at ordinary temperature—which is in the neighborhood of 16 tons per square inch—is diminished by more than 60 per cent when the temperature of the metal is raised to 500 degrees C. It is therefore necessary to conduct the welding operation in such a manner as to avoid fractures due to contraction.

The electric conductivity of copper is slightly less than that of silver. Owing to its high electric conductivity it is used for telegraph, tramway and other conducting wires.

The welding of copper conductors, omnibus bars, etc., does not modify the resistance in the welded joint. The electric conductivity is diminished very considerably by even slight traces of impurities.

The presence of impurities also modifies many of the mechanical properties of copper. The fractures produced when welded articles are machined or worked hot, and which are generally attributed to defective welding although often outside the weld altogether, are very frequently due to impurities in the metal itself.

Bismuth is the most objectionable impurity, as even a very small quantity renders the metal so brittle that it cannot be worked either hot or cold. Antimony and arsenic have very similar actions, but the former is much more objectionable. Arsenic hardens copper and increases its textile strength, and for many purposes its presence is not only not objectionable, but is advantageous. Phosphorus ameliorates the mechanical properties, but when the quantity is large the metal is rendered very brittle.

Copper is comparatively soft and flows readily under pressure, so that it is both malleable and ductile and can be rolled into thin sheets or drawn into fine wire, and can be worked into any required form by stamping or spinning. When the metal is worked it becomes hard and to a certain extent loses its ductility, but it is restored to its proper degree of toughness by annealing. When copper

Fig. 1. Blowholes in a Copper Weld Executed with An Electrolytic Copper Welding Rod.

is being worked it must be repeatedly annealed to avoid fracture. It should be possible to hammer an oxy-acetylene weld on copper until the metal is quite thin without showing any crack.

The ultimate strength of copper is approximately:

	Pounds per square inch.
Copper castings	19,000 to 26,000
Ordinary	33,000 to 26,000
Pure wrought	36,000 to 26,000
Copper wire	38,000 to 60,000

The specific heat of copper is about 0.094 and its coefficient of linear expansion 0.000006 for each degree Fahrenheit rise of temperature. Copper is not acted on by dry air or oxygen at ordinary temperatures. It comes into the market in ingots of various sizes. The principal varieties of commercial copper are:

1. Electrotype copper, prepared by electro deposition from solution. It is usually very pure.

2. Best selected (B. S.) copper. This is a very pure form, and is mainly used for the manufacture of alloys.

3. Tough copper. This is the ordinary commercial copper.

Copper, when employed by itself, is largely used for many purposes. The ductility and the ease with which it can be bent or set to any required form have led to its extensive use of pipe work, hemispherical pans and such like forms. Copper, when combined with other metals to form alloys, is extensively used for engineering purposes.

The Melting of Copper.

The melting of copper in contact with the atmosphere is always accompanied by chemical and physical phenomena which always tend to diminish the qualities of the metal.

A copper weld executed with a very pure copper welding rod—electrotype, for example, will be found to be riddled with blow holes. These blow holes are easily shown by cutting the weld transversely and then, after polishing the surface, usually by fine grinding on emery papers of increasing degrees of fineness, treating the polished surface with a solution of ferric chloride acidified with hydrochloric acid or other suitable etching fluid. A weld treated in this manner is shown in Fig. 1.

The density of copper melted with the blow pipe, is diminished very largely by the presence of blow holes. The blow holes are caused by the absorption of gases and, in the case of pure copper melted with the oxy-acetylene blow pipe, on solidification a phenomenon similar to the "spitting" of silver takes place.

If the oxy-acetylene flame contains an excess of acetylene the absorption of gases and the apparent boiling of the metal are considerably increased.

Copper in the molten condition oxidizes very rapidly; this oxidation is extraordinarily intense, and is capable of transforming the metal into an actual alloy of copper and copper oxide.

Fig. 2. Copper Oxide in Copper Melted During Welding. Magnified 100 Diameters.

Oxidation of Copper, Constitution of Copper Oxide.

Whenever copper is melted in the presence of air it forms an oxide which is very rapidly dissolved in the metal. It is practically impossible to have perfectly pure copper in the molten state, as it is difficult to avoid contact with the atmosphere. It is for this reason difficult to find exactly the melting point of copper. The temperature taken in a molten bath of copper is that of a mixture of pure copper and dissolved oxide.

The melting point of copper, containing copper oxide up to the point of saturation, is 1,068 degrees C. (1,956 degrees F.). This temperature is the melting point of the eutectic alloy of oxide and copper containing four to five per cent of oxide.

This oxide, or cuprous oxide (Cu_2O) as it is called, can, after solidification, be present in the weld in several states. It may be isolated in bluish crystals grouped in tree-like forms and known technically as a "dendritic" structure. This form is shown in Fig. 2. At other times the metal consists of islets of pure metal surrounded by the alloy of copper and copper oxide previously mentioned. This state of oxidation is shown in Fig. 3, and represents to a magnification of 50 diameters, the edges of a plate of electrolytic copper melted rapidly with an oxy-acetylene blow pipe properly regulated. The white islets of copper surrounded by the greyish cement of the alloy copper—cuprous oxide—are clearly seen to the left of the figure.

The presence of crystals of oxide or of the eutectic of oxide and copper in the interior of a weld renders the

metal brittle, and cracks are produced under shocks from a hammer. Appreciable amounts of oxide present are shown by the appearance of the fracture which in such cases is granular and of a dull red color. Cuprous oxide present in small quantities is not harmless—in fact, in ordinary commercial copper the presence of a certain proportion of copper oxide is found essential to the good quality of the metal.

The oxidation of copper is therefore always produced when the metal is melted, the oxidation is diminished by limiting its contact with the atmosphere.

The Influence of Flame Regulation.

The nature of the flame of the blow pipe influences the fusion of copper. It is well known that the properly regulated flame gives as the products of the first phase of the combustion hydrogen and carbon monoxide, but this does not prevent the inevitable oxidation by the atmosphere.

An excess of acetylene in the flame increases the effervescence or bubbling of the metal. A weld made with such a flame contains therefore a very large number of blow toles. Again, the formation of oxide being due to the oxidizing action of the atmosphere, the effervescence of the copper

Fig. 3. In the Part Melted Islets of Copper Surrounded by the Alloy Copper—Copper Oxide. Magnified 50 Diameters.

produced by the excess of acetylene exposes more surface of metal to contact with the air and the oxidation is considerably increased.

Fig. 4 shows a microphotograph of a sample of copper melted in the presence of an excess of acetylene. In addition to the two large blow holes, the numerous crystals of oxide are noticeable; the left portion contains a very large quantity of the utectic alloy of oxide and copper mixed with the metal.

An excess of oxygen gives, in the part of the flame utilized for welding, carbon dioxide and water vapor. Carbon dioxide gas possesses the curious property of diminishing the absorption of gases. The melting of the metal in the presence of an oxidizing flame is therefore very calm and no effervescence is produced. Nevertheless, carbon dioxide and water vapor are energetic oxidizing agents at high temperatures, and it follows that the oxidation of the metal is very intense. *It is obvious, therefore, that the welding of copper should be done with a flame normally regulated.*

The blow pipe should be held in such a manner that the white part of the flame, commonly known as the white cone, is at a distance of ¼ to ⅜ inch from the surface of the metal. If the separation is too considerable, in other words, if the tip of the white cone is at too great a distance from the metal, the intensity of the oxidation of the metal is increased, due to the fact that as the distance is increased, the outer mantle of the flame, containing carbon dioxide and water vapor, come into contact with the molten metal.

Conditions that should be fulfilled by a welding metal or rod for use in the welding of copper.—In welding copper the welding rod used should satisfy the following conditions:—

(1) In order to render the work easy, its melting point should not be different to that of copper.

(2) In order to give a weld free from blow holes it must absorb as little gas as possible.

(3) It should contain a deoxidizing element capable of destroying the dissolved oxide. This deoxidizing element should diffuse very readily in the molten metal and give, by the reduction of the oxide, a slag which has no tendency to remain imprisoned in the metal. It is further necessary that the percentage of the deoxidizing element should be just sufficient to purify the metal melted under the blow pipe, as *an excess of the deoxidizer may modify the mechanical properties of the weld.*

The use of electrolytic copper does not satisfy these

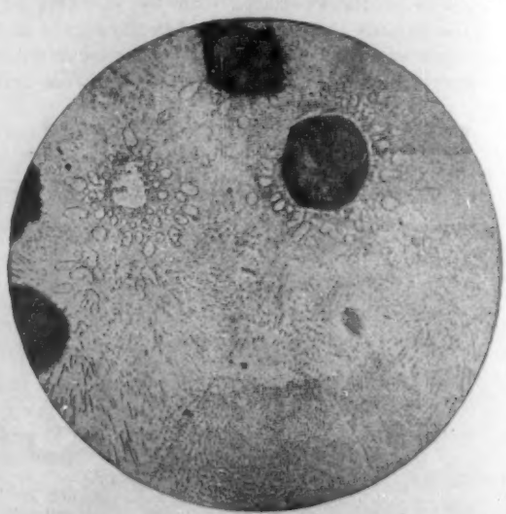

Fig. 4. Copper Melted with a Blowpipe Containing Excess of Acetylene. Blowholes and Oxide Magnified 200 Diameters.

conditions; moreover the welds made with pure copper lack strength because it is impossible to destroy the oxide formed during the welding operation.

It is not possible to destroy the oxide of copper with a flux, no matter what composition of flux is used. The newly formed oxide is dissolved in the molten mass and is unaffected by the superficial action of a flux.

To destroy a metallic oxide, that is, the combination of a metal with oxygen, it is necessary to use an element capable of depriving it of all its oxygen. If, for example, the oxide of copper is heated in the presence of carbon or carbonaceous matters, this latter body, having a great affinity for oxygen, attacks the oxide, robbing it of its oxygen and producing as a result pure copper. The separation of the metal from chemical combination is known as reduction and substances that remove the oxygen from metallic oxides are known as reducing agents.

The old bronze founders realized the necessity of destroying or reducing the oxides formed in metal that had been molten for some time. To reduce the oxide they swept and stirred the molten metal with green wood, the reducing gases from the wood are thus set free by the high temperature of the molten metal, the oxides are reduced and the metal assumes its normal condition.

(To be continued.)

THE USES OF CARBON IN WELDING INDUSTRY

By B. Kopferschmidt

When the oxy-acetylene welding was in its infancy, before there was any established authority, our primitive welders performed their operations without any labor or material-saving devices. In the course of the evolution of the gas welding process, the time has arrived when we can boast of a great many new devices, that enable an ambitious welder to do his work more efficiently and economically.

Some of the most important devices that have been recently introduced are carbon plates, blocks, rods and paste. These carbon products became so important in the writer's department that some of the principal operations could not be performed without their aid.

The efficiency obtained in vertical cast iron welds made it possible to perform the heaviest welds on castings without dismantling them: and also reinforce the weld to any thickness desired, by using a wider carbon block than the weld and grooving out as much as desired, so as to obtain the thicker weld. .In building-on work, such as lugs, bosses or broken pieces of castings, a great saving in time, labor and material is obtained.

Instead of the slow process of building on metal on a small vertical edge a carbon, cut out so as to correspond with the original lug, is placed against the fracture and the weld is made in a horizontal position, quicker, cheaper and better. With the latter method 60 per cent of labor and gas is saved. No welding rod metal is wasted, as it all melts in the space provided by the carbon edges and casting. To build up a lug, a corner, or any other broken part in a casting with a carbon wall around it, so as to hold the molten metal, does not require as much skill as would be required to perform the same operation without the carbon.

Carbon blocks and plates are far more superior than fire clay or fire bricks, which are liable to fuse under the heat of the blowpipe. When carbon blocks are used, the edges of a weld are smooth, regular in shape, which saves machining, while the clay or bricks leave the edges irregular, full of blow holes, requiring machining.

Another good feature is that when a cast-iron weld is surrounded by carbon blocks the heat is held at the place where it will do the most good, and the surface of the molten metal is kept from being oxidized by the atmosphere. There is also a small distribution of carbon in the molten metal, which produces a soft surface at the weld.

Although we have a great many sizes of carbon blocks and plates, the most favorable for acetylene welders are: 6″x6″x 1″; 6″x3″x½″; 12″x1″x1″; 12″x3″x¼″, and 15″x6″x1″.

The carbon rods are used to save redrilling of holes or to make up a center core. The favorable sizes are ⅜″, ½″, ⅝″, ¾″, 1″, 1¼″, 1½″ and 2″.

The carbon paste is a carbon mixture which at ordinary temperatures is plastic, and on heating it becomes as hard as the carbon block, without cracking or shrinking from its original size. It can be used to block any shape or opening; in welding locomotive cylinders it will make an ideal core for the portholes. The paste is used in building on metal for new teeth on gears, or for protecting threads near the welding line. Carbon paste is shaped between the fractured teeth and one can weld in the same size teeth and save the cost of milling.

In my visits to some large and small welding shops, this product was used very little, or not at all; therefore, it would be well to give it a proper test and perhaps others may find some more uses that will increase the field of welding operations.

Cast iron becomes harder each time it is melted, therefore use a special welding rod containing silicon, which tends to soften the weld.

EYE PROTECTION FOR WELDERS.

You all know how a welder's eyes burn and smart after a day spent with the torch, if he is not protected with the proper goggles, and some of you may know of cases where welders have gone partially blind after several days of continuous welding, even when the eyes have been protected by glasses.

Unfortunately, in a case like the above, the welder either through ignorance or neglect has failed to provide himself with the proper kind of eye protection.

For the benefit of the men who are just taking up welding, let us try to describe the rays of light that eminate from the flame of a welding torch. All light is composed of the different rainbow colors, known as the invisible spectrum. At either end of the visible spectrum are rays of light known as the invisible rays, and these are the ones that are harmful to the eyes.

Beyond the red end of the spectrum are the rays known as the infra red, and beyond the blue end of the specturm are those known as ultra violet.

Both infra red and ultra violet rays of light are extremely harmful, and investigation has shown us that both of them are prevalent when the welding torch is in use.

The first glasses that were used by welders to protect their eyes were either dark blue, dark smoke or dark amber. These, for some reason or other, did not seem to give the desired protection, and welders obtained goggles of darker shades than they had been using. These simply cut down the vision of the operator and did not seem to benefit the eyes. The reason for this was that they had no action on the invisible rays of light, or if they had any action, had not sufficient to eliminate the danger.

While conducting some experiments with colored glass, after the harmful invisible rays of light were discovered and their danger recognized, it was found that by combining certain colors of the spectrum that were nearest to the center in color, color was obtained that prevented the ultra violet and infra red rays from passing, and allowed the remainder of the rays of light to pass.

A glass of this color seemed to be the ideal one for the protection of the eyes of those working under extreme light conditions. It was only necessary to obtain such a glass in the different densities of shades, depending upon the intensity of the light.

After considerable time spent in experiments, it was found that the best glass to use for the protection of those doing either ox-weld acetylene or electric welding was one that combined the discovered color with a smoke color, and it was finally found that the two colors—greenish smoke and the new color—could be combined in one lens, and this was given the name of "Noviweld."

Noviweld glass has been given tests by safety inspectors, representatives of insurance companies, the Underwriters Laboratories and by engineers throughout the country, and it has been approved as being a glass that gives the required protection.

It is ideal in that it protects from the harmful rays and also cuts down on the illumination, just enough so that the workman can see to do his work.

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*Paper by S. H. Polasky (F. A. Hardy & Co.) before American Association of Welding Engineers, Jackson, Mich.

Do not mistake malleable iron, which is used in rear housings and other parts of an automobile, for cast iron. It cannot be welded with cast iron. Use care in welding any cast iron which has been previously brazed. Be sure all brass has been removed.

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Welders and the War.

IN 1898 it was not a very difficult matter to secure a commission in the Army. As a result we put a very poorly officered Army in the field. The rest is history. During the present crisis we sometimes fear that the Army folks at Washington, wishing to safeguard the road to shoulder straps, are sitting up so straight they are leaning backward.

For certain classes of duty, in connection with the training of a big army, inspection of materials, munitions, etc., ability from a mechanical standpoint should be the paramount consideration. For instance, the applicant for commission might possess big shoulders and a sound physique, but still be a poor excuse to put in charge of the training of welders. We should imagine that ability as a welder would come first.

The people are being told of a mighty fleet of aeroplanes we are going to put in the field, also a huge flotilla of truck, ambulances, officers' cars, etc. We in the welding trade can realize this means welders aplenty, if aeroplanes and automobiles are to be kept in service. Where these welders are to come from we are at a loss to know, and it is to be hoped the Government will give the matter earnest consideration before we are confronted with a situation which will be hard to meet.

In the last few weeks at least three members of the trade have been denied admittance to the new army because of minor physical defects. Each of these applicants was, however, well qualified to organize the schools in which Army Welders must be trained.

Food Conservation.

WHILE the Food Administration Bill is still in the formative stage in Congress and its final scope and authority has not been defined, Mr. Hoover, acting under the authority of President Wilson, is endeavoring to enlist the voluntary aid of the whole American people in a campaign to conserve food, fuel, power and transportation. It is obvious that no legislative action should be necessary in a work of this kind.

Every publication, every organization, and every person in the United States must be reached, not once, or twice, or ten times, but constantly until the war ends. Men, women and children must be enlisted as willing volunteers through the periodicals they read, the organizations they belong to, the moving picture theaters, the billboards, the fairs, and every other channel.

These are times of perplexity in Washington, with a great many parts of the war program to be got under way. Sometimes it looks as though there was a good deal of confusion. Criticism is common, and discouragement part of the day's work. But one point stands out always, everywhere, unquenchably cheering—we know that editors, publishers, business men, leaders, and the whole American people are waiting to go to work loyally the moment that Washington is ready to point out a definite work to be done.

Most readers of technical journals are something more than consumers. They are employers, superintendents, managers. They are leaders of groups of consumers, with opportunities to influence others in this matter of food saving.

The Draft in Munitions Centers.

THERE is general approval of the thoroughness and care with which the draft is being put into effect. Employers are seeing, however, with increasing clearness that the population estimates on which the draft quotas have been made up throw a most inequitable burden on the centers of production of war supplies.

Two factors have brought about this injustice—the presence of a large floating population of men of the draft age and the very high percentage of aliens in both the permanent and temporary populations. Bridgeport, Conn., is an example. Its actual population probably does not much exceed 185,000; its population estimate furnished by the Census Bureau for draft purposes is 278,000, based upon a registration of over 26,000. A majority of the registrants are aliens. The minority citizen element is composed largely of young men in training to be the skilled machinists, tool and gage makers, forgers and brass workers, from whom must be drawn the directing forces of production in the coming years, perhaps in a single year if war necessities demand the continued rapid expansion of Bridgeport's industries such as has marked the past two years.

While it is true that the provision for exemption of industrial workers opens a way to hold many valuable men in industry, employers are none too eager to appear before the Federal district exemption boards and ask for the retention of large groups of employees. They appreciate that under Bridgeport's conditions the wholesale exemption of factory workers on top of the heavy exemption of aliens and those with dependents will impose the entire burden of military conscription upon a comparatively small class of clerical mercantile and public service employees and the younger men of the professions.

SOLDERING ALUMINUM.

F. E. Totten.

The writer of this article wants it distinctly understood at the start that he is not an advocate of aluminum soldering in place of acetylene welding, especially in places where there is any strain, but in places where there is no strain, such as a sandhole or a small crack in a transmission or crank case, soldering is easier and will serve the purpose very well.

There are a great many aluminum solders on the market today, and they all doubtless have their merits.

For the sake of brevity we will only quote four formulas of solders designed to solder aluminum, the first of which the writer is particularly fond of and if used according to directions will give unvarying satisfaction.

(1) 61 parts block tin,
36 parts zinc,
3 parts copper.

(2) 12 parts tin,
2 parts zinc,
1 part aluminum,
1 per cent sodium chloride.

(3) 2 oz. aluminum,
2 lb. 2 oz. zinc,
1 lb. 11 oz. phosphor-tin,
5 lb. 7 oz. block tin.

(4) 5 parts tin,
3 parts zinc,
2 parts lead.

The necessary tools are a good, heavy rasp or file, a chisel to V out the crack (if it is a crack to be repaired and the metal is thick at that point) and a small half-round file (an old file will do very well, attached to a suitable handle) and a convenient source of heat.

A Prest-O-Lite soldering torch, a gas and air torch; or if nothing better can be had a gasoline blow torch may be used.

The first two above mentioned are so far superior that whenever possible one or the other should be used.

If the man who intends to do soldering has no gas and air it is a simple matter to unstrap your lighting tank and hitch a soldering torch to it with a suitable length of hose.

The reader must not confuse a soldering torch with a so-called soldering iron, as an open, clean flame must be used and a degree of heat is required far greater than any soldering iron is capable of producing.

Now for the process of soldering: We will suppose that we are to solder a crack in a transmission case.

With our sharp chisel we will V out the crack nearly through the case, being sure to leave no dirt or grease of any kind in the crack. Now with our rasp, file a space clean and bright for a half inch to an inch all around the crack; now follows the tinning operation, which is the one operation that must be done right to insure successful soldering. Tinning, as its name implies, consists of spreading a thin coat of solder over the place to be soldered in order that there may be more solder added, and have it stick.

Turning on our Prest-O-Lite soldering torch until we have a good hot flame or our gas and air flame, whichever one we are using, we play the flame directly on the spot to be tinned, holding the torch just far enough back that the greenish inner cone of our flame just touches the metal.

The purpose of holding that particular part of the flame on the metal is to minimize oxidation. When the reader is told that freshly cut or scraped aluminum oxidizes quickly at ordinary temperatures and much more rapidly when heated he will readily see that the outer cone of a flame which is oxidizing must not be used or a film of oxide of aluminum will be formed that will make it almost impossible for the solderer to make his tinning stick.

After the heating has been in progress for a minute or so, taking a stick of solder, aluminum solder in one hand and touch the part of your case under the flame gently with a slight rubbing motion. If the stick melts and coats the surface of your case the case is hot enough to start tinning. If it does not melt, continue heating until it does.

When the case is hot enough to melt the solder, smear on a little more of the solder, then lay down your stick of solder and pick up your old file, grasp it firmly and start rubbing the solder that was smeared around the crack, holding your file at an angle of about 45 degrees, and rub with the outermost end of the file. Then rub, rub, rub the solder in the crack and all around it until you can just feel the solder taking hold and every bit of the filed surface is covered with a thin coat of solder. It takes time and practice and elbow grease to do a good job of tinning, but when you once "catch on" it is easy.

It must be remembered that the flame must be held on the spot to be soldered during the entire tinning operation. While there is not much danger of melting your case, care should be exercised that it does not happen. The purpose of the rubbing motion in tinning is to scrape what oxide has formed during the heating operation ahead of the file, while just behind the file comes the thin coat of solder and covers the scraped place before the air has had time to attack it. The rubbing also works solder into the pores of the case.

While the tinning is still hot, melt enough more solder to fill the crack and make a neat patch, smoothing the solder out with the hot file. The solder should be plastic, but not "running hot."

If you want to make a particularly nice job, take a small, flat, smooth pine stick and smooth it up. The wood being a poor conductor of heat will not chill the metal and makes a very smooth job.

The flame should not be played on the solder while you are smoothing it up with the pine stick, as it will char it and solder will adhere to it and drag across your patch, making it rough.

When cold the solder looks very much like the aluminum and when struck with a hammer sounds very much like the rest of the case.

One need have no fear of internal strains as the heating is too slow to cause them; neither is there any danger of cracking the case, and no special precautions need be taken.

The four formulas were quoted more for information than recipes that the solder should make up, and I advise that he purchase it ready made from some reputable dealer in such supplies.

Positively no fluxes of any kind must be used with aluminum solder.

WELDING AIDS ECONOMY.

Since its beginning, the world war has drawn so heavily on the metal industries as to seriously interfere with the normal production of machinery and metal parts. Soaring metal prices and a shortage of skilled mechanics have made it difficult for American manufacturers to get new machinery or repair parts without considerable delay and investment.

Now that the United States has been compelled to unsheath the sword a still greater demand for "war goods" is inevitable. Millions of tons of machined metal will be needed. National safety demands that all available skilled labor and necessary metals be thrown on a "war footing" to insure the successful outcome of the world war.

It will be increasingly difficult for the average manufacturer to obtain new machinery and other metal equipment, and it becomes not only a necessity but a patriotic duty for every manufacturer to utilize the equipment he has—to reclaim for service the broken and worn machinery and parts that have hurriedly been consigned to the scrap-pile.

Today, while manufacturers are clamoring for machinery

and replacements, there are literally thousands of the very pieces wanted reposing in junk-heaps, rendered unserviceable by a break, crack or worn spot. They represent millions of dollars in what is now valuable metal and workmanship.

That practically every piece of this metal equipment, which manufacturers have discarded as junk, can be restored to service quickly and at a trifling cost by oxy-acetylene welding is the subject of a nation-wide campaign being conducted by The Prest-O-Lite Co., Inc., of Indianapolis, Ind. The campaign, which is being run in general and technical magazines, points out the possibilities of the process of oxy-acetylene welding and cutting in the conservation of time, metals and labor by reclaiming the scrap-pile.

Aside from a strong dollars and cents' appeal to progressive manufacturers, the campaign points out a way of avoiding costly delays incident to getting new equipment and of helping the national conservation movement.

The practice of reclaiming broken and worn metal parts by oxy-acetylene welding, as well as applying the process to manufacturing metal products is, of course, not new. The process has been in extensive use in thousands of mines, mills, foundries and factories for some years. In these days of high-priced metals and uncertain deliveries, however, the process must hold some interest for every far-sighted manufacturer who has not heretofore looked into its possibilities.

THE CONTINENTAL CARBIDE POSITION.*

The economic difficulties caused by the European war, now going on for nearly three years, are increasing visibly, not only for the belligerents, but also for the neutral countries.

The more the end of hostilities approaches, the more the crisis is aggravated. It will certainly reach an unheard of degree before the end of the war, of which we cannot form even an idea.

The misery and the rapidity with which it increases, gives us with certainty the greater or lesser distance we are from the end of hostilities.

As our readers will have learnt, either through their own experience or through their reading, they know that if there is not a lack of carbide, there is, in any case, an urgent question respecting it. It can be said with truth that there is a lack of carbide in the belligerent countries. The demand for it there has reached, for some time already, an extreme intensity. All the newspapers contain permanent advertisements reading somewhat as follows: "So-and-so many truck loads of carbide wanted."

Business in carbide has been done by people of all callings: Lawyers, chemists, journalists, iron merchants, publicans, engineers, building contractors; in any case, by many people who had nothing to do with the trade before the commencement of hostilities. The Swiss Acetylene Corporation has also received numerous demands of this nature, both from Switzerland and from abroad.

The scarcity of carbide at last led in most countries to administrative measures of a very onerous nature. In Germany a decision of the Federal Council of 12th January, 1916, ordered the general seizure and stock taking of carbide. The necessary steps were taken in consequence and orders issued. By these orders the obtaining of carbide for private industries, if not exactly prohibited, has been rendered practically impossible. For repairs, and also for lighting houses, the use of carbide will, in the long run, be prohibited.

The German periodicals for acetylene and autogenous welding, which, up to the present, have worked to develop the use of carbide and acetylene, have been compelled to look out for and propose other means to replace acetylene for welding and lighting. It seems ironical to see them suggesting today the use of coal gas and of hydrogen for welding, when formerly they showed and proved clearly how unsuitable these gases were for important welding work. For acetylene lighting only very small burners of [illegible] ft. per hour may be employed, of course, provided that the users can obtain carbide for this purpose.

For private industrial purposes in Germany the scarcity of carbide is great. Users would pay willingly £[illegible] per ton of carbide, if it were possible to obtain it at this price, which has, indeed, already been paid to intermediaries. And it must not be overlooked that this is the state of affairs, although the production of carbide has been enormously increased there, since the war began. The production will be this year, according to official estimates, 300,000 tons.

In France the conditions are scarcely more favorable for private industries or for the great carbide industry. In certain cases carbide has already been prohibited for use in lighting apparatus. Even the large factories which work exclusively for the national defense have been obliged, if not to stop working, at least to reduce their production.

In addition, the French production of carbide has not been increased since the commencement of the war in the same proportion as the German production. This has not been felt to be so necessary in France, where acetylene and carbide are not utilized to replace chemical products for rubber, manure, etc.

Any carbide which private manufacturers may receive costs an enormous price. Sixty pounds per ton in truck load of 10 tons has already been paid. The normal price of carbide in France, in full truck loads, is £36 per ton. (Note by the Translator.—In France it is customary to sell the carbide by gross weight, i. e., with the drum weighed in, this being equivalent to an increase of about 6 per cent in the price.)

In Belgium and in Holland £80 to £90 per ton is paid. These countries do not themselves produce carbide, and as they are between Germany on the one side and France and England on the other, they are in a particularly disagreeable position. Germany has prohibited the carriage of carbide for other countries, while England buys the Norwegian carbide as it is produced.

What is now the situation in Switzerland? It would be almost mean to compare our difficulties with those of our neighbors. It is not realized, in many places, how we have been favored up to the present. Nevertheless the matter must be ventilated, for nobody knows what may happen in our country.

*Translation from "The Bulletin of the Swiss Acetylene Association," of March, 1917.

CAST IRON BOILER SECTIONS.

Editor: Kindly advise whether it is possible to weld cast iron boiler sections, such as hot water and steam sectional house heating boilers, a type similar to the Ideal boilers, as made by the American Radiator Co. If so, kindly give full information as to process, as there is a great deal of work of this kind, which can be secured, if we can guarantee satisfactory results.

Asheville Supply & Foundry Co.

Answer: It is entirely feasible to weld cast iron boiler sections, such as hot water and steam sectional boilers, but it would be impossible, however, to give you a set of general instructions covering this work.

If you will select the particular subject and send me a pencil sketch of the job completed, I will be pleased to send you instructions and details. Editor.

OXY-ACETYLENE WELDING *in* MACHINE SHOP, SHOP *and* TOOL ROOM*

By J. H. Rodgers

Autogenous welding, on account of its adaptability to general engineering practice, has become an indispensable factor in metal manufacturing industry. The subject matter herewith shows to what extent this process can be adapted to the requirements of general machine shop and tool-room construction and repairs.

DURING the last few years considerable progress has been made in the autogenous welding of metals by the oxy-acetylene process, and recently, engineers and manufacturers have realized its undoubted possibilities in lowering costs of production. And as an adjunct to the tool room, the saving effected by this process has been particularly noticeable. In the construction of a jig or fixture, one has generally the choice of two methods: To prepare a pattern from which a casting is made, or to build up from stock material or forgings; each having its own advantages. With the first method welding is not required, unless it is to reclaim a casting that has been spoiled through error, or developed blow holes in machining, when welding would effect the repairs rapidly and cheaply.

It is in the construction of jigs of the build-up type that oxy-acetylene welding will be found of the greatest benefit.

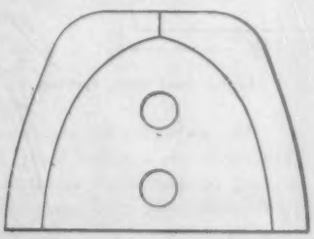

Fig. 1. Stellite-Faced Cutter.

The majority of them can be built up from old pieces of material while the use of intricate forgings is done away with. In such cases, the alternative would be to drill, screw down and dowel the parts together, a method which never very satisfactory, particularly if the jig is subjected to much vibration, as the screws always have a tendency to work loose. Parts can also be welded quickly together, that, from their shape, could not be screwed with any security. Bosses, ribs, webs, etc., can be built up direct from the feed rod, allowing material of lighter section to be used, and dispensing with a great deal of machining. Snap and other gauges of the fixed limit type can be reclaimed when worn out, at a very trifling cost, by adding new metal to the jaws and regrinding to the proper size. This is one instance only of the innumerable ways that the oxy-acetylene plant handles not only efficiently and quickly, but very cheaply, the numberless jobs which come into the tool room from day to day.

Case Hardening.

Ordinary case hardening is generally obtained by carbonizing the outside shell of mild steel pieces, thus transforming the exterior skin to a high carbon steel, giving hardness. Such result is obtained by putting the castings or other pieces, in contact with incandescent carbonaceous substances, so that the metal absorbs the carbon. The characteristics of a case hardened piece are shown by the thickness of the skin transformed in the steel, and as the percentage in carbon decreases from the outside to the inside, a case hardening well done should affect a sufficient thickness of metal treated, and the percentage of carbon should decrease gradually from the outside to the inside and should not be constituted by a film of hard metal without a transitory period of the original metal. Case hardening done by means of an ordinary mixture made of charcoal, carbonate of baryum, or organic matter, leaves a surface which does not split or crack even when showing much hardness, because the decrease of carbon is regular; but case hardening made by rubbing special

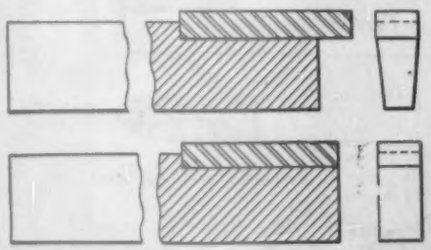

Fig. 2 and 3. Oxy Acetylene and Electricnlly Welded Tools.

powder (generally containing ferro cyanide of potassium), on small parts which are red hot, gives a very hard skin but not very thick, which is liable to flake away during tempering.

The use of the oxy-acetylene blowpipe for case hardening permits the obtaining at will, according to the handling of the blow-pipe, either of the above described results; that is to say, a deep layer with gradually decreasing percentage of carbon, or a thin, very hard layer. To obtain deep and quick case hardening, the blow-pipe should be well regulated and the end of the inside tip of the flame should be kept at a distance of about one inch of the metal treated; when the desired temperature is attained, a slight excess of acetylene should be given. The flame contains an excess of free carbon which is very readily absorbed by the metal, which is being kept hot by the heat of the flame. To obtain a thin and very hard layer, the inside tip of the flame should be kept close to the part being treated care being taken at all times not to burn the metal.

The following results have been obtained from experiment, care being taken to keep the piece at a cherry red heat while being treated: (a) With the white inside cone of the flame kept for two minutes, at 5/8 inch off the metal, open hearth steel has been given a high carbon layer of metal 1/2 m.m. deep, and

*Reprint from Canadian Machinery.

the surface of the metal showed a percentage above two per cent., consequently giving a case hardening similiar to chemical powder. (b) Holding the inside flame of a blow-pipe, with an excess of acetylene, 1¼ in. from the metal during a period of ten minutes, the case hardening effected a thickness of three m.m. without the exterior skin, showing a richness of carbon superior to 0.85 per cent. of carbon. Consequently, case hardening by the blow-pipe gives very interesting results; an application of 2 minutes is sufficient to give to a surface a hardness comparable to the treatment of the most active hardening powder, while by lengthening the application to from 5 to 10 minutes, case hardening can be obtained showing a depth of 2 or 3 millimeters, of a very regular character, and with a gradually decreasing percentage of carbon, the highest percentage not being high enough to provoke flame during tempering.

Surface Hardening.

The use of the blow-pipe for case hardening should not be confused with its use for surface hardening. In the first case, the excess of carbon purposely produced in the flame, changes the chemical composition of the steel being treated, while being kept hot with the blow-pipe; while in the second case of surface hardening, only the heating power of the blow-pipe is used as a convenient way to apply heat to the surface of a piece of steel, while the rest is kept cool with running water or other

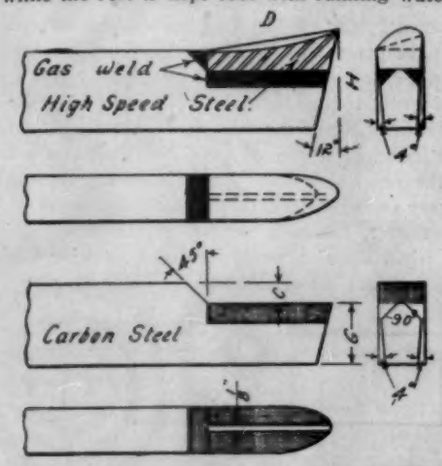

Fig. 4. Preparing Tools for Welding.

devices. This oxy-acetylene hardening process is a cheap and rapid method of hardening; it is applicable to such purposes as the hardening of the surface of gear teeth, castellated shafts and bores, template holes, and in general to the localizing hardening of any small area upon large articles, particularly where the ordinary hardening process would cause distortion that would be difficult to remove afterwards by grinding.

Surface Hardening of High Tensile Steels.

A system of surface hardening which can be applied to local parts of any coating or forging of high tensile steel, without involving distortion and without destroying the effect of the usual heat treatment to which the whole casting or forging may have been subjected, has been perfected. The equipment usually supplied for oxy-acetylene welding is used, four sizes of burners meeting all requirements. The work to be hardened locally, is placed in a tank of water with adjustable overflow, so that the water level can be regulated, as while the portion of the surface being hardened is instantly heated to the required temperature, the whole of the remainder of the article is kept as cool as possible by being immersed in water. Should the immersion method not be possible, the part not being hardened must be kept cool by water flowing over the surface. The burner is held so that the outer portions of the flame flow in the direction along which the burner is travelpasses along, the surface is instantly cooled by the cold body ing, and the portion of the steel heated should be cooled. when intense hardness is desired, by arranging that cooling water shall flow as close as possible to the traveling burner, but not so close as to disturb the flame, because that is not only liable to put it out, but prevents rapid heating and causes irregular hardening. The flame required should be of the highest possible temperature and burn close to, or even under water, this high temperature being obtained by adjusting the flame as for welding, and then increasing the pressure of the oxygen so that the flame changes color and appearance from a white cone to a bluish streaked tongue, when observed through smoked glasses. In this method the essential to success is the speed of the heating; as the flame of the remainder of the forging or casting, leaving it at the maximum hardness of which the steel is capable when heated and quenched in cold water.

To obtain a thin, but intensely hard surface, the part to be hardened should be just below the surface of the water, the impinging flame blowing the film of water away. The normal depth of hardening is about ⅛ inch, but a greater depth, up to ⅛ or ¼ inch, can be obtained by slightly prolonging the heating. A slight wave or rotary movement should be given the flame to avoid burning the surface of the steel. Contrary to what might have been expected, even with the hardest steels, there is no tendency of the hardened surface to crack or flake away from the unhardened portion. In a number of cases made for examination, not a single instance shows any parting between

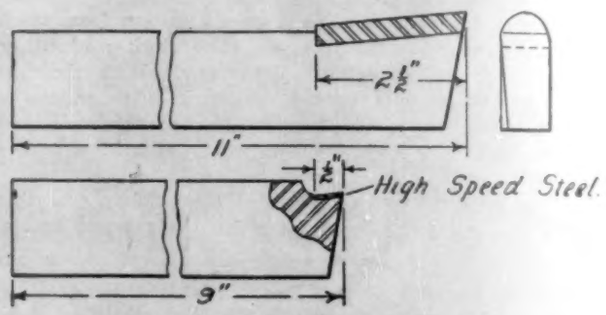

Fig. 5. Lathe Tool with Welded Tip.

the hardened and the unhardened portions. While the process in the above case is applied only to high tensile steels, it is of interest to engineers to note that cast iron and black heart malleable iron castings can also be given a glass hard surface by hardening in this manner with the oxy-acetylene process.

Stellite and the Field Opened to It by Oxy-Acetylene.

This wonderful high speed tool metal (which the manufacturers claim is "not a steel, but its master," and which will cut out 25 to 300 per cent faster than the best high speed steel, is so hard that it cannot be forged and will cut as well when red hot as when cold), had one very serious disadvantage, which very considerably retarded its more general adoption; this disadvantage was its brittleness, which generally prevented stellite being used in the solid tool form, but necessitated its use in a tool holder. Apart from the general objections to tool holders of using stellite was only partially successful, as even with the best designed tool holders, it was impossible to support the metal right up to the cutting edge, with the result that any slight jar or an extra hard spot encountered, the stellite would break away through want of sufficient supporting. The total holder was supplanted to a certain extent by using electric welded tipped tools, but as is subsequently pointed out, electric welding is limited to certain straight work of predetermined section, and consequently this did not overcome the difficulty to any great extent.

Stellite can, however, be worked with perfect ease, with no limitation as to size or shape, under the oxy-acetylene

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blow pipe. An oxy-acetylene stellite built tool gives an ideal tool, presenting the extremely hard cutting qualities of the stellite, with the absence of tempering and minimum of grinding; supported homogeneously on a low grade steel shank which will withstand the severest shocks and has the same hardening adaptability and heat radiating features of a solid tool. The method of tipping is different to the welding of high speed steel, in this respect, that no previously prepared tip is needed, but the stellite is used in the form of a filling in rod and fused direct on to the shank, which has been preheated in the ordinary way; ⅜-inch stellite rod has been found to give the best results. This method of facing has the particular advantage that any form or shape of tool or cutter can have the cutting edge lined with stellite. Fig. 1 shows a very interesting example of this work. The cutter in question was an ordinary rough cutter for boring 6-inch high explosive shells; it was machined on the cutting edge ¼ inch wide and ⅛ inch deep, and then built up with stellite, ground and put into service, and up to the time of writing it had bored 119 shells without any further grinding, and was still in good condition. A stellite tipped rough turning tool turned sixty shells with only one grinding of the tool. Small ordinary circular tools for facing shell base plates, tipped with stellite, gave equally good

Fig. 6. Profiling Cutters Repaired.

results, and in no case of the tool under test did the stellite come away from the shank of the holder, when fused on by the oxy-acetylene process.

Welding High Speed Steel.

It is perhaps in the field of welding high speed steel tips to carbon steel shanks that the greatest saving can be effected; with the present price of high speed steel at $3 per pound, a tool for ordinary heavy work of 1½-inch section, would weigh approximately 9 pounds, and would cost, without any labor charges for forging, etc., about $27. The relative cost of a tipped tool using ½ pound of high speed steel at $1.50 and 8½ pounds of carbon steel shank at $1.02 (12 cents per pound), giving a total cost of $2.52. It will be found in actual practice that the cost given for the tipped tool is excessive, as the high speed tips are made up from short pieces of steel, broken cutters, etc., which have only a market value of scrap steel, and the shanks, except in the case of very large users, are pieces reclaimed from the scrap pile.

There are three methods in general use of welding these tips: (a) by means of welding flux; (b) by the electric process, and (c) by the oxy-acetylene process. The first method has been adopted in a number of shops with varying degrees of success, due largely to the fact that each engineer has his own ideas as to the ingredients of the flux. A patent has, however, recently been granted covering a specific flux; but irrespective of the kind of flux used, its field of operation is strictly limited. In the second method, that of electric welding, the limitations refer more particularly to the capital outlay necessary, which prevents the system being adopted in any but large plants where welding work is continuous. Also, the preparation of the tools in electric welding has to be carefully thought out, for it is essential in making a butt weld that the cross sectional area of the two pieces be equal. This entails considerable loss of time and material in grinding the necessary clearance. To illustrate: Fig. 2 shows a tool that has the necessary clearance for use, but which it would be practically impossible to weld electrically, while Fig. 3 shows one that is correct for electrically welding, but would require considerable grinding for use. These welding limitations do not apply to either flux or oxy-acetylene welding.

It must also be remembered that with the electric process, the heat is bound to be concentrated upon the point to be welded, and no local annealing of the metal around the weld is possible, as is the case when gases are employed. This question of local annealing is one of vital importance. There are, of course, certain classes of work for which electric welding is the most suitable method to employ, but in general, a gas welding plant is better and more adapted to general work shop use.

The third method, oxy-acetylene welding, has no limitations outside the skill of the operator. Tips can be welded or irrespective of the size or shape; broken cutters can be welded together, or additional metal can be used to fill up the gaps, etc. In a perfect weld, the union of the two pieces should present the same chemical composition and physical characteristics as the jointed surfaces. Under these conditions the entire joint posesses a homogeneous structure and no variation in the mechanical properties should be disclosed in the different portions. This is where the oxy-acetylene process is distinctly in advance of any other at

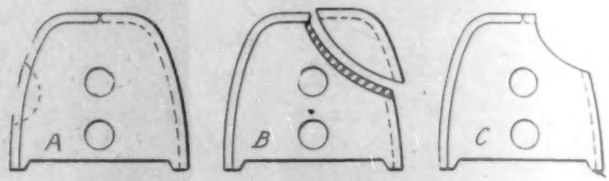

Fig. 7. Repairs to Flat Boring Cutters.

present in general use. It uses as a filler, metal of exactly the same chemical composition as the parts to be welded, and when combined with this is an advantage of welding any shape or size of tool with equal ease, it can be more fully appreciated why a gas plant for general work shop use, is better and more adaptable.

Preparing Tools.

The general practice adopted for repairing or tipping lathe, planer, or other metal cutting tools is to bevel the shank as shown in Fig. 4. The lower view shows the shank prepared for welding, and the upper view the appearance of the tool after the weld has been made. This can be done most economically by the blacksmith when forging; the tips should also be cut by the smith to the approximate shape, to saving grinding as much as possible, and also with a view to utilizing all odd and small pieces of the more expensive grade of steel.

Preheating.

With the object of avoiding as much as possible, the interior oxidization of high carbon steels, it is good practice after the shank and tip have been prepared, to heat before welding, and to weld with a powerful blow pipe, reducing the time of welding to the minimum, thus obtaining a more homogeneous weld. Preheating should be arrested at a red heat, which permits of a regular execution of the weld by avoiding local overheating, the interior oxidization being less intense and the work more rapidly performed. At all times, it is advisable to reduce as much as possible, the interval between the commencement and completion of the fusion.

Welding.

The shank and tip having been preheated, the former should be placed on the welding bench and the steel tip placed in position and tacked; that is, attached to the shank with a small piece from the welding rod. The tool should then be turned on each side successively and welded in on the space left by the beveling, to the uniform service of the tool, care being exercised at all times to avoid playing

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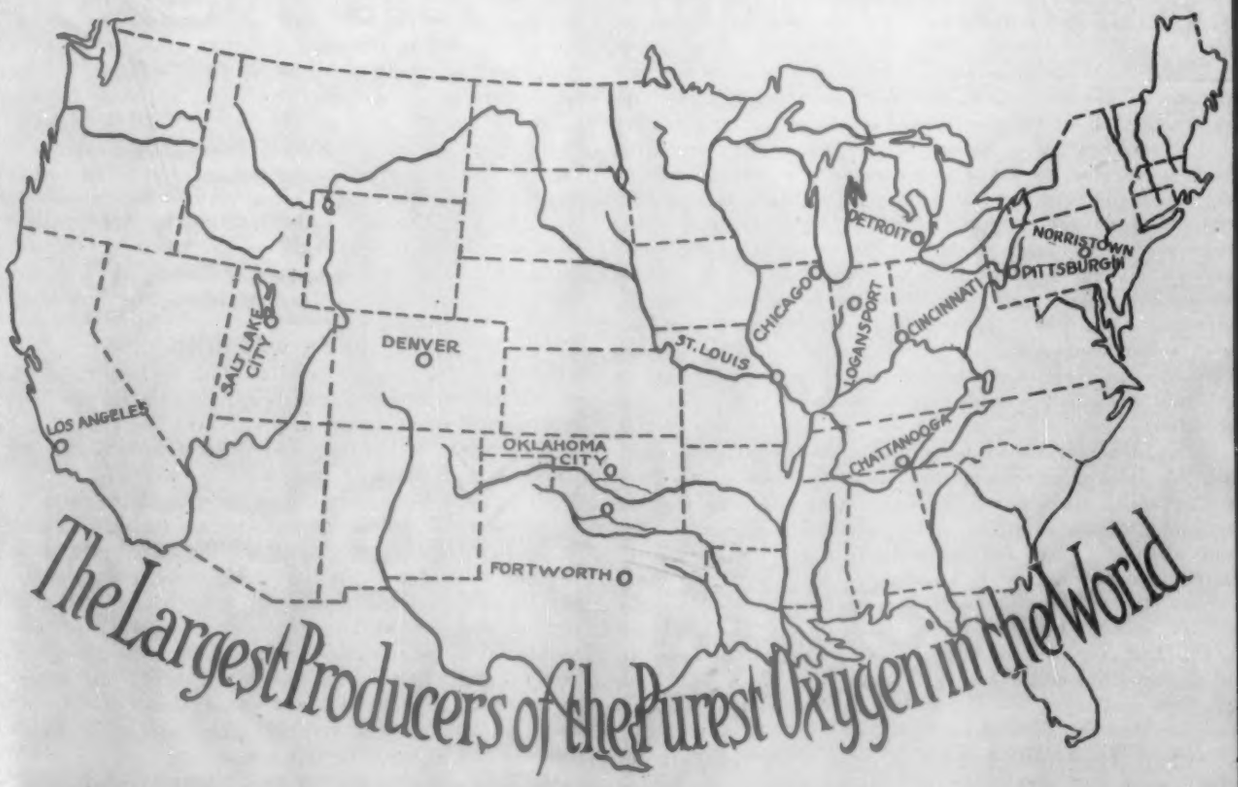

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the flame too long in the one spot, as this has a tendency to burn the metal.

Filing Materials.

The welding material used for welding high speed steels, to carbon steel shanks, may be either Swedish iron or vanadium steel rods, the latter giving the best results of the two. In special cases, such as welding a broken cutter or filling up a gap on the cutting edge of a boring cutter or drill, steel of the same quality as the defective tool should be used.

Heat Treatment.

A point that many manufacturers overlook, is the physical properties of high speed steel and ordinary tool steel; these are so different that strains are set up by welding, unless the pieces are heat treated before they have a chance to cool down from the welding heat. Therefore, to obtain the greatest efficiency, a furnace should be near the welding bench, where heat treatment can be accomplished; in general practice, where the life of the tool is of short duration, the tool is not treated in the furnace, but buried in lime or asbestos as soon as welded.

Examples of Oxy-Acetylene Welded Tools.

Straight tipped tools are used in very large numbers and actual working experience has been that they are equal in every respect to solid tools, and when properly welded and hardened, the tips wear to the last small piece. Fig. 5 shows one of these tools, (a) shows the tool used for rough turning, tipped ready for use, and (b) shows the condition of the same tool when it comes out of the machine shop for retipping. These tools are comparatively easy to weld, and therefore will not be of so much interest as the following examples, which demonstrate the oxy-acetylene process occupies a field entirely its own, doing work that cannot be done by any of the other welding processes.

Circular tools are used for various kinds of profile work, and their delicate construction often results in cracking or breaking when being hardened or defects may develop after being put into service. In Fig. 6 are shown several of these tools that have been effectively reclaimed after breaking. They are 1½ inch outside diameter, 4 inches long and a ⅝-inch hole drilled through the center; the sizes given are of course not standard, as they have to conform to the particulars of the tool box in which they are being held. (A) shows a tool which was broken in three parts, evidently due to overheating or hardening. It was welded up, using high speed steel as a filler, afterwards heat treated and rehardened, and then put into service; after three days of continuous work (day and night shift), during which time it was reground as necessary, it showed no defects at all and could not be distinguished from a new solid tool. At (B) is shown the same type of tool beveled at the edges on the grinding wheel ready for welding. At (C) is shown one with a chip broken out of the side, ready for filling up, and (D) one that was worn too short to be properly held in the tool post, being welded on to a carbon steel and construction.

Every engineer knows the difficulty and expense in keeping flat boring cutters up to standard dimensions. They are generally made in two sizes, finishing and roughing, the general practice being to make them to the finished size, and when too small for this purpose regrind them for the roughing operation. It is also known that the life of these cutters is very short and erratic; sometimes they will strike a hard spot in the steel being worked, and burn, leaving a gap that very often destroys the cutter altogether. In other cases the cutter cracks through or a piece will break off, thus destroying the tool unless some satisfactory means can be used for reclaiming the same. These cutters can, of course, be machined down to form smaller cutters for other work, but the initial cost of the original machining has been lost, and most manufacturers will be able to estimate what that loss represents in their own business. In Fig. 7 is shown several flat boring cutters that have been successfully reclaimed from the scrap pile; (A) illustrates a cutter that had a gap on one of the cutting edges, as indicated by the dotted line, which was filled in with steel of the same grade as that of the cutter with excellent results, making the cutter as good as new. At (B) is shown a similar cutter that was broken, with the pieces ready for welding, and (C) shows another cutter where the broken part was lost. This cutter was successfully built up to its original size with added steel of the same grade.

The size or shape of cutter or tool, or the nature of the break, make no difference whatever to the process, for, as stated previously, the only limitation is the skill of the operator. Examples like the foregoing could be given in indefinite numbers, but each one would only be a repetition of the fact that an oxy-acetylene plant in the tool room, is not a luxury, but a stern necessity.

Operation.

Despite the fact that welding work generally is now on a more scientific basis than formerly, along with the ease with which an oxy-acetylene plant can be handled, so much so that sufficient knowledge may be acquired in one or two days to enable a man to turn out useful and profitable work, the successful attainment of high skill in welding is still a difficult matter and considerable practice and concentration are essential to become perfect in the proper manipulation of the blow pipe. It should be borne in mind that there must necessarily be different grades of welding operators in exactly the same sense as there are different grades of tool makers, machinists, etc., as perfection is more a human than a mechanical factor. Indeed the ease of handling the oxy-acetylene torch has been one of the ever recurring difficulties that manufacturers of the apparatus have had to contend with. In the ordinary course of tool room work, when a difficult of intricate tool or jig has to be made, the foreman generally picks out one of the best men to do the job, and in case of failure, the cause is thoroughly investigated and the blame apportioned accordingly; but with the oxy-acetylene process, sentence is invariably passed without any investigation, and the general verdict is. "It is no good for that kind of work." This summary treatment is due, in a great measure, to the lack of knowledge of welding principles, not only on the part of operators, but also on the part of their foremen.

It is not to be understood from these remarks that a number of welding operators are necessary, but in handling work of a specific nature, a man should be trained who understands the nature of the material he has to handle in tool work, cutters, etc., such as described in this article; a good tool backsmith or a man skilled in tool tempering is the ideal material from which to obtain the best results.

FLUE WELDING.

Editor: We have a job of welding seventy flues, 4 inches in diameter with oxy-acetylene process. Can you offer any information which might help us? We are expecting to cut new pieces 12 inches long and weld in each end of old flue. About how much will each weld be worth?

McKittrick Bros.

Answer: We do not quite understand what you are going to do. If you are lengthening out the flues by 12 inches, cut the old flues at a slight bevel and make a butt weld. You say that you are going to weld in each end of the old flue and we are somewhat in doubt as to whether you mean to butt weld to a new piece or weld into the flue sheet. If you are going to weld the flue to the sheet by all means read an article on page 19 of the February issue of *The Welding Engineer*, as this is a very complete description of the correct method of handling this work.

If you desire further information, please send a sketch of proposed work. Editor.

Hold on! What were you doing just then? Storing away that interesting bit of welding experience, or a photograph, perhaps? Don't do it? Give it to us. We want to show it to 4,099 other readers of The Welding Engineer (you're the forty-one hundredth). If there are objectionable features to it, just leave it to the Editor (he studied surgery), cutting off and adding to is his hobby.

Another thing, when you work out a successful solution to a welding problem write us about it. Grammar and composition don't count—it's ideas we want. If a sketch would illustrate your job in good shape, just make a rough pencil sketch; our draughtsman will do the rest.

If the welding industry is to grow, you welders must pass along your experiences. We pay for them.

THE WELDING ENGINEER

608 S. DEARBORN ST., CHICAGO

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Explains in a simple manner apparatus to be used, its care, and how to construct necessary shop equipment. Proceeds then to the actual welding of all automobile parts, in a manner understandable by everyone.

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A Comprehensive Treatise on the Practice of Welding Cast Iron, Malleable Iron, Steel, Copper, Brass, Bronze, and Aluminum by the Oxy-Acetylene Method, together with concise information on the Equipment required for both Welding and Cutting by this Process

By S. W. MILLER

337 Pages, 6 x 9 Inches, 192 Illustrations

PRICE $2.50

Ten years ago the oxy-acetylene method of welding and cutting metals was hardly more than a laboratory process, but in the course of these few years it has become one of the most important of the methods in the metal-working industries. Much has been published relating to this process, but a great deal of that which has been placed on record in the past has been descriptive of odd jobs. It is, therefore, believed that the present volume, dealing in a more systematic manner with the principles and practice of the art of oxy-acetylene welding, will be of considerable value to those engaged in the metal trades.

The information here presented on the subjects of oxy-acetylene welding and cutting has been mainly furnished by S. W. Miller, proprietor of the Rochester Welding Works, whose wide experience in the practical application of the process, and whose success in the work, vouch for the reliability of the information here placed on record. The experience of the author in the oxy-acetylene welding field has been unusually extensive, but having been mostly on repair work, he has written especially for those engaged in a similar line. A great deal of the work done with the oxy-acetylene welding torch is on repairs, and while there are also a great many applications of it in manufacturing work, such applications are more or less special in each case, and sometimes require a great deal of experimenting before success is attained. The general principles here presented, however, apply equally to repair and manufacturing work. This volume describes the equipment required for oxy-acetylene welding and cutting, deals in detail with methods used in welding cast iron, malleable iron, steel, copper, brass, bronze, and aluminum and gives in addition, special attention to the welding of sheet metal, tank welding, boiler repairs, etc., as well as to the subject of lead burning, which is a special kind of autogenous welding.

The book contains twelve chapters headed as follows:

Equipment for Oxy-acetylene Welding.
Preparation of Work for Welding.
Materials and Fluxes used for Welding.
Making Oxy-acetylene Welds.
Oxy-acetylene Welding of Cast Iron.
Welding Steel, Malleable Iron, Copper and Copper Alloys.
Welding Aluminum
Sheet Metal, Boiler, Pipe, and Tube Welding.
Oxy-acetylene Welding of Tanks and Retorts.
General Considerations in Oxy-acetylene Welding.
Lead Burning.
Cutting Metals with the Oxidizing Flame.

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LOCATING CRACKS IN CRANK SHAFTS OR OTHER CASTINGS AND FORGINGS.

In the course of welding heavy crank shafts and other important equipment forwarded to our Jersey City shops for repairs, we have found in many cases that while the part to be welded will be broken clear through in one place, there would also be one or more additional hair-line cracks which would usually give trouble later on if not welded at the same time. We presume that the strain thrown on the casting when the break occurred is often sufficient to start small cracks elsewhere. Sometimes these cracks are so minute that they are not visible to the naked eye, and it is extremely difficult to locate them no matter how carefully the entire section is cleaned and inspected.

A very efficient method which we are now using is to paint the entire section with a mixture of whiting and alcohol. The whiting and alcohol should be mixed together to form a good white paint not too thin. This dries very quickly and becomes discolored by grease or dirt in the small hair-line cracks so they show up very clearly. We cannot say that this method would show up a crack in a brand new casting, as it appears that the small amount of grease which usually works its way into these small hair-line cracks is what causes the whiting and alcohol to become discolored. The part to be painted should of course be thoroughly cleaned of all surface dirt or grease before applying the whiting and alcohol.

Of all the crank shafts sent us to weld, we believe that it is a conservative estimate to state that one out of every three has contained additional cracks which were only made visible by the whiting and alcohol method. If these had not been found the shaft would probably have broken later on in one of those locations.

We recommend to our customers that they follow this practice, as it is much cheaper to complete all the necessary welding in one operation than to have the shaft break in another location and have to go through the welding and machining again.—*Reactions.*

MONTHLY MEETING OF WELDING ASSOCIATION

The regular monthly meeting of the American Acetylene Welders' Association was held at Jackson, Mich., the first week in August. Several matters of importance were discussed and six new members were admitted. Several committes were appointed, and in this connection the president said, in part:

"One of the most important committees that I intend to appoint tonight is the Examination Board. We have been receiving a great many requests from welders for an efficient examining board. I know the spirit of our own men favor examination, to see what they lack and what they ought to study.

Examining Board

G. W. Evans, Lansing, Michigan.
U. S. Barton, Battle Creek, Michigan.
J. H. McIntosh, Jackson, Michigan.
A. F. Dillon, Jackson, Michigan.
J. Bruderer, Detroit, Michigan.

The duties of this board are to meet once a month for the purpose of examining welders or cutters, as to their proficiency, and issue diplomas as to their qualifications. The board is to report once every three months to the Executive Committee.

Nominating Committee

S. Goldfarb, Jackson, Michigan.
C. Briggs, Jackson, Michigan.
G. H. Sherwood, Jackson, Michigan.
G. W. Evans, Lansing, Michigan.
U. S. Barton, Battle Creek, Michigan.

The duties of this committee are to present to the organization, at the annual meeting, a list of candidates, two names for each office. The officers shall be voted for separately.

Auditing Committee

G. W. Evans, Lansing, Michigan.
A. W. Young, Jackson, Michigan.
G. H. Sherwood, Michigan City, Indiana.

The duties of this committee are to examine the accounts of the Treasurer and Secretary, and report at the annual meeting.

Program Committee

A. F. Dillon, Jackson, Michigan.
F. M. Butler, Detroit, Michigan.
E. G. Cady, Jackson, Michigan.

The duties of this committee are to present a program for the meetings of the ensuing year, at the annual meeting.

Membership Committee

L. B. Mackenzie, Chicago, Ill.
A. F. Dillon, Jackson, Michigan.
E. G. Cady, Jackson, Michigan.
F. E. Totten, Jackson, Michigan.
E. E. Myrick, Jackson, Michigan.

The duties of this committee are to receive all applications for membership and investigate the qualifications of each applicant, and report to the Executive Committee for action.

Ways and Means Committee

H. S. Smith, Indianapolis, Indiana.
P. F. Willis, St. Louis, Mo.
L. B. Mackenzie, Chicago, Ill.
P. D. Taylor, Roswell, New Mexico.
F. E. Totten, Jackson, Michigan.

The duties of this committee are to devise and direct the plans for raising money and carrying on the work of the organization.

Safety First Committee

P. F. Willis, St. Louis, Mo.
F. E. Totten, Jackson, Michigan.
John Bruderer, Detroit, Michigan.

The duties of this committee are to devise and direct safety first ideas and report at each monthly regular meeting.

Efficiency Committee

P. F. Willis, St. Louis, Mo.
G. W. Evans, Lansing, Michigan.
H. Sidney Smith, Indianapolis, Indiana.

The duties of this committee are to devise and direct new operations to be performed more economically and efficiently and reports to the Executive Committee at the regular monthly meetings.

Investigation Committee

G. W. Evans, Lansing, Michigan.
S. Evanier, Pittsburgh, Pa.
John Bruderer, Detroit, Michigan.

The duties of this committee are to investigate all cases that may arise from members or from any concern and to report to the Executive Committee at each regular monthly meeting.

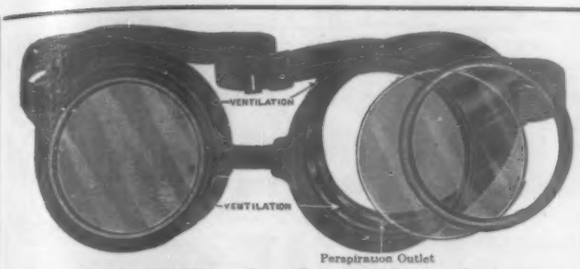
Electric Welding Committee

C. Belcher, Jackson, Michigan.
H. A. Purdy, Jackson, Michigan.
C. T. Blake, Jackson, Michigan.

The duties of this committee are to attend to all correspondence, give free advice and examine members engaged in electric welding. They are to report to the Executive Committee every three months.

Entertainment Committee

S. Goldfarb, Jackson, Michigan.
C. Belcher, Jackson, Michigan.
G. H. Sherwood, Jackson, Michigan.
A. N. Lewis, Jackson, Michigan.
R. J. Gusenbar, Jackson, Michigan.



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Written by one of the oldest and most progressive authorities on the subject of welding. An up-to-the-minute text book, written for the purpose of giving the welder the greatest amount of information for the least possible cost. The first 1,000 volumes will be sold at 50 cents after which the price will be advanced to $1.00.

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Orders filled Day and Night

Superior Oxy Acetylene Machine Co., Hamilton, Ohio

The duties of this committee are to take charge of any outing, visiting, lectures or conventions held by the association, and to make a program for such events for the entertainment of the members and families.

The association will hold an outing the first Sunday in September. It was also decided to start a library in Metallurgy, Chemistry and Welding, and authors and editors will be asked to donate works of interest.

A paper on eye protection for welders was read by Mr. S. H. Polasky, of F. A. Hardy & Co., Chicago.

NEW PREHEATING BOOKS.

Two new publications, of interest to the welding trade, have been issued by the Hauck Manufacturing Co., 140 Livingston Street, Brooklyn. Bulletin No. 90-W is entitled "More Heat At Less Cost." It describes the use of Hauck oil burning torches in the welding shop. Some very good suggestions are offered the welder and torches of various sizes are fully described.

Bulletin No. 89-W is entitled "Practical Heat Application In Auto and Repair Shops." This book also contains many good illustrations of the proper method of preheating welding jobs. Both books will be sent on application to the Hauck Manufacturing Co.

IMPROVED WELDING TORCH.

The Bishop Babcock Becker Co. has marketed a new welding torch as illustrated above. This torch has a single tube and it is therefore possible to do the lightest and heaviest welding by simply changing the tubes.

The manufacturers state that when the proper gas pressure is obtained it is practically impossible for this new

torch to back fire, regardless of the size of tip used. This feature will be appreciated by every user, as it not only saves a great deal of time, but eliminates considerable trouble.

Attention is called to the fact that while this welding torch is durably constructed it is light and easy to handle, being designed to fit the hand. It is said that the torch is simple to operate and skilled labor is not required. The illustration shows that the valves are conveniently placed below the handle, and a proper mixture is secured without difficulty. The manufacturers, whose general offices and factories are located at Cleveland, Ohio, will be glad to give further particulars, and will send a complete catalog describing their oxy-acetylene welding and cutting apparatus upon request.

BUFFALO DENTAL 50 YEARS OLD.

The Buffalo Dental Manufacturing Co., of Buffalo, N. Y., wish to announce their Fiftieth Anniversary in the manufacture of high class specialties for brazing and welding purposes, such as brazing blowpipes; preheating blowpipes; foot blowers and power blowers for air blast, etc.

In all these years they have kept abreast of the times and improved these appliances to meet the varying conditions in the grades of gases, so the operator using the "B. D. M. Co." product might be sure he has the best the market affords, and rest assured it will perform successfully the duties for which it was designed without loss of time or temper. A new catalog "B. X.-50" just from the press will be found a most valuable reference work, and may be had for the asking.

NEWS.

Members of the International Acetylene Association met in New York on August 3rd for the purpose of considering the desirability of holding the regular convention this year.

R. M. Klein has been appointed sales manager of the International Oxygen Co.

Mr. M. Keith Dunham, of New York, is spending a couple of weeks in Chicago.

R. W. Austin, formerly with the Imperial Brass Manufacturing Co., has started a business at 613 West Jackson Boulevard, known as the Austin Welding Works.

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Count 8 words to line. Add 6 words for keyed address.

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Wanted: A first-class oxy-acetylene welder for all kinds of auto work, aluminum especially. There is an especial advantage in this position. Good hours, good salary and rapid advancement after proving worth. Give full particulars in first letter or no notice taken. Address Welder, Box 93, Copley Sq. P. O., Boston, Mass.

Wanted: First-class oxy-acetylene job welder. State experience in detail and salary expected. Address Eastern, care *The Welding Engineer.*

Wanted—Oxy-acetylene welder wishes position. Highest references. Address R 2, care *The Welding Engineer.*

Wanted—An experienced acetylene welder. Communicate with the Independent Welding Works, 510 East Water Street, Syracuse, N. Y.

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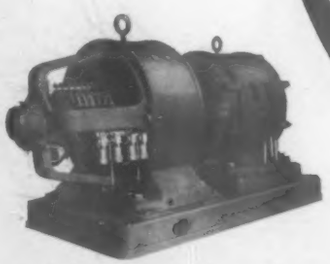
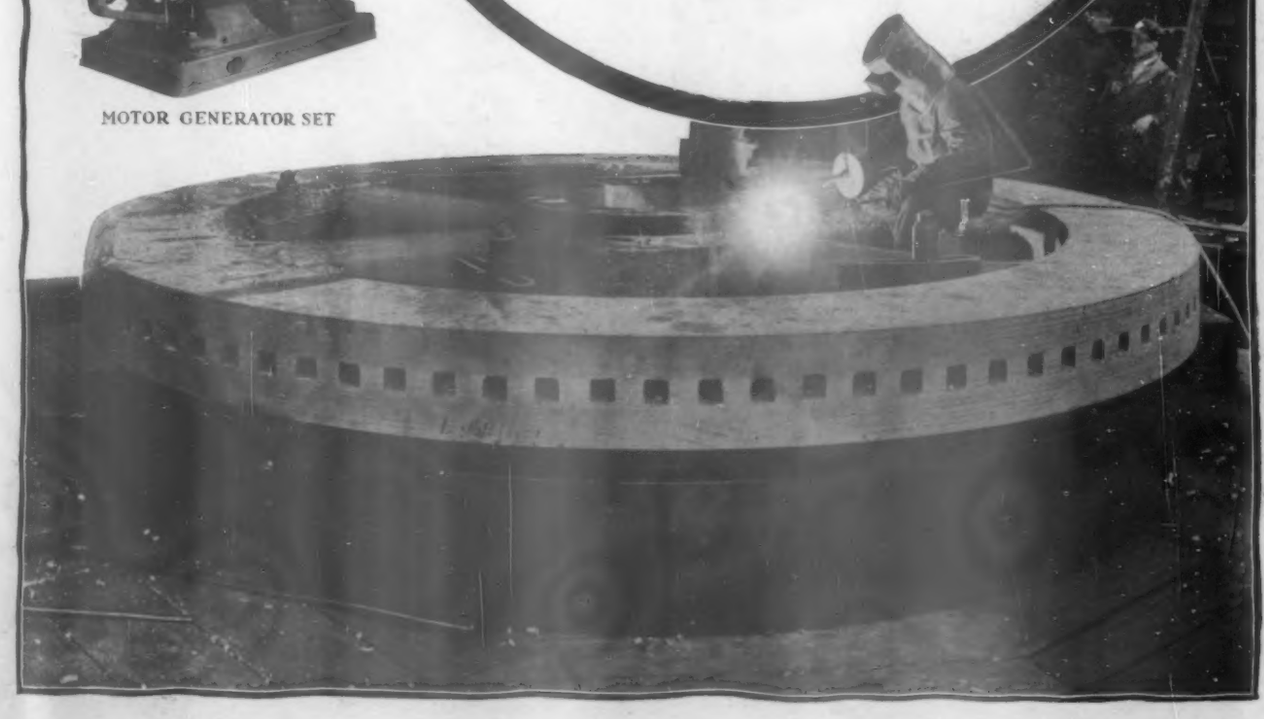
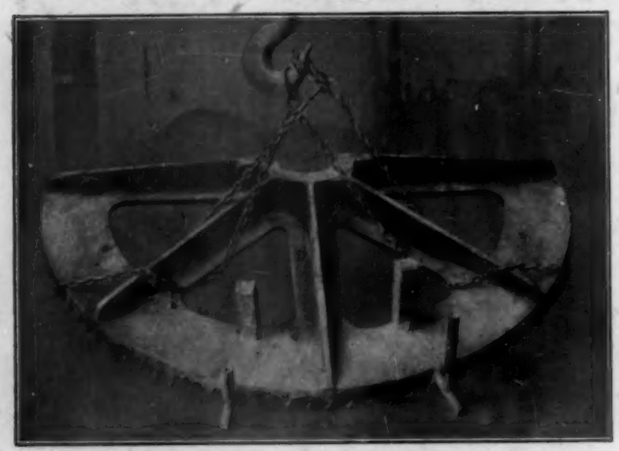


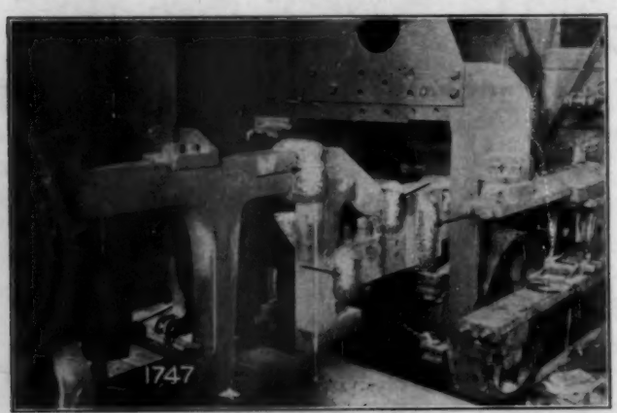
MOTOR GENERATOR SET



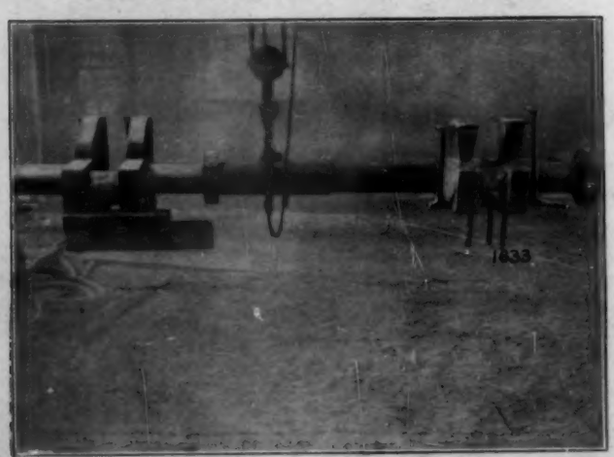
New neck cast on to large roll made with the aid of Thermit and having the pods cast in at the same time.



Large bevel gear on which two new teeth and crack have been repaired.



Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



New crank pin welded in by the Thermit Process.

Thermit Does the Heavy Welding and Does It Right

The Thermit Welding Process is the only one that is best adapted to repairing of heavy sections (see illustrations).

Thermit will repair such sections quickly and economically. Many serious delays have been avoided from the use of Thermit Welding and saved thousands of dollars in time and expense.

If you have a breakdown

wire or telephone our nearest office and we will proceed at once for arranging the shipment of materials and send an expert to supervise the repair.

We have an eighty-page pamphlet devoted exclusively to this class of work, which is known as pamphlet No. 1779, and tells how the work is executed and how you can do the work yourselves.

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